MASSACHUSETTS BAY PROTECTION ACT OF 1988

HEARING

BEFORE THE

SUBCOMMITTEE ON FISHERIES AND WILDLIFE CONSERVATION AND THE ENVIRONMENT

AND THE

SUBCOMMITTEE ON OCEANOGRAPHY

OF THE

COMMITTEE ON MERCHANT MARINE AND FISHERIES HOUSE OF REPRESENTATIVES

ONE HUNDREDTH CONGRESS

SECOND SESSION

ON

H.R. 4883

A BILL TO AMEND THE FEDERAL WATER POLLUTION CONTROL ACT TO INCLUDE MASSACHUSETTS BAY, MASSACHUSETTS, IN THE NATIONAL ESTUARY PROGRAM

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CONTENTS

	Page
Text of H.R. 4883	14
Statement of:	
Davies, Tudor T., Director, Office of Marine and Estuarine Protection, Environmental Protection Agency	2
Prepared statement	19
Davis, Hon. Robert W., a U.S. Representative from Michigan	18
Delaney, Richard, assistant secretary, executive office of environmental affairs, Commonwealth of Massachusetts	4
Prepared statement	25
Kaufman, Jay R., executive director, Massachusetts Bay Consortium	9
Leahy, Brian M., manager, intergovernmental affairs, Massachusetts Water Resources Authority (prepared statement)	74
Studds, Hon Gerry E., a U.S. Representative from Massachusetts, and Chairman, Subcommittee on Fisheries and Wildlife Conservation and the Environment	1
Wallace, Gordon, associate professor, Environmental Sciences Program, University of Massachusetts at Boston	6
Prepared statement	53
Additional material supplied:	
EPA:	
Excerpt from Newsweek of August 1, 1988, entitled: "Don't Go Near The Water"	39
Excerpt from Time of August 1, 1988, entitled: "The Dirty Seas"	46
Wallace, Gordon T., Jr.: Article from New England Journal of Public Policy entitled: "The Reclamation of Boston Harbor: A Scientist's Perspective"	61

MASSACHUSETTS BAY PROTECTION ACT OF 1988

TUESDAY, JULY 26, 1988

HOUSE OF REPRESENTATIVES, SUBCOMMITTEE ON FISHERIES AND WILDLIFE CONSERVATION AND THE ENVIRONMENT, AND SUBCOMMITTEE ON OCEANOGRAPHY, COMMITTEE ON MERCHANT MARINE AND FISHERIES,

Washington, DC.

The subcommittees met, pursuant to call, at 1 p.m., in room 1334, Longworth House Office Building, Hon. Gerry E. Studds [chairman of the Subcommittee on Fisheries and Wildlife Conservation and the Environment] presiding.

Present: Representative Studds.

Staff present: Will Stelle, counsel; Suzanne Waldron, press secretary; Lisa Murray, research assistant; Jeffrey Pike, senior professional staff; Larry Flick, minority professional staff; Joyce Sacco, clerk; and Tom Laverty.

Mr. STUDDS. The subcommittees will come to order.

OPENING STATEMENT OF HON. GERRY E. STUDDS, A U.S. REPRESENTATIVE FROM MASSACHUSETTS, AND CHAIRMAN, SUBCOMMITTEE ON FISHERIES AND WILDLIFE CONSERVATION AND THE ENVIRONMENT

Mr. STUDDS. We convene this afternoon for a hearing on H.R. 4883, the Massachusetts Bay Protection Act. That act proposes to include the Greater Massachusetts Bay-Cape Cod Bay into the National Estuary Program under the Clean Water Act.

The increasing decline of the environmental quality and ecological health of our coastal waters and coastal resources is a subject that has commanded the attention of these subcommittees over the course of this Congress. We have dedicated countless hours and what will be a total of 8 oversight hearings into every major aspect of the degradation problem, ranging from toxic industrial and municipal discharges to poor state water quality standards programs to uncontrolled leaching from improperly functioning septic systems to surface runoff from our farms and city streets. Each source has its particular cause and each its particular solution.

Our focus today is on solutions. The proposal to include the Massachusetts Bay-Cape Cod Bay into the National Estuary Program looks to an effort to plan for the future in Eastern Massachusetts.

Our purpose today is to examine the current state of environmental quality in the larger Massachusetts Bay-Cape Cod Bay; to assess if indeed the trends there justify a renewed effort to arrest

environmental decline; and to judge if we ought to channel those efforts through the National Estuary Program or proceed along another course.

I very much look forward to today's testimony. I want to welcome our panel of witnesses, and I thank you all for taking the time to appear here today.

As you may or may not know, the House is in session. In a short time there will be some three bills out of this subcommittee on the floor, and it may be necessary to recess briefly to be on the floor for debate on those bills. We hope that doesn't happen, and we apologize in advance if it does.

We have four witnesses and we will have you proceed as your name appears on the witness list. We would appreciate if you would confine your oral statements to 5 minutes.

We will start with Mr. Tudor T. Davies, Director of the Office of Marine and Estuarine Protection, EPA.

STATEMENT OF TUDOR T. DAVIES, DIRECTOR, OFFICE OF MARINE AND ESTUARINE PROTECTION, ENVIRONMENTAL PROTECTION AGENCY

Mr. DAVIES. Thank you very much.

You addressed questions to me in your letter of invitation regarding the range of pollution problems facing Massachusetts Bay-Cape Cod Bay, the degree to which these problems are currently being addressed, the benefits of participation within the National Estuary Program and the likelihood of securing funding in the future.

The litany of problems impacting Boston Harbor and Massachusetts Bay-Cape Cod Bay is not new. Major pollutant discharges into the bay include municipal waste, sewage sludge and combined sewer overflows. Other activities that affect the bay include dredging, waste disposal, residential and industrial development, and agriculture.

Elevated levels of PCB's, PAH's and metals are present in the sediments of Boston Harbor and its tributaries. In certain hot spots, sediment concentrations of these chemicals are among the highest in the world.

The pollution problems in Massachusetts Bay are the result of long-term loadings of pollutants from these industrialized urban areas. Lobster taken from Boston Harbor suffer from shell and black gill disease, while winter flounder exhibit a high incidence of fin rot and neoplastic lesions. A recent study by EPA found similar conditions and incidences of disease in Quincy Bay. Along the coast of Massachusetts Bay and Cape Cod Bay, productive shellfish areas are closing due to bacterial contamination.

The Massachusetts Department of Health recently issued a dual human health advisory regarding: one, the consumption of lobster tomalley taken from urban embayments throughout the bay, and, two, the consumption of lobster, white flounder and clams from the harbor by sensitive populations—women of childbearing age and children under twelve.

The Massachusetts Water Resources Authority is in the process of a cleanup program which includes new wastewater treatment

and sludge processing facilities, the capture and treatment of overflow sewage during rainfall events, renovations of the sewers to eliminate leaks, and reduction of toxic discharges to the sewer system.

The new primary treatment plant will be completed and permanent sludge facilities will begin operations by 1995. Secondary treatment facilities will be operational by 1999. By 1991 interim sludge facilities will be completed, ending the discharge of sludge into the harbor. Other municipal dischargers into the bay are in the process of upgrading to secondary treatment.

In 1987 Congress amended the Clean Water Act, formally establishing the National Estuary Program, NEP. The NEP is a nationwide demonstration program targeting selected estuaries of national significance that are threatened by pollution and population pressures. The purpose of the NEP is to protect and improve the water quality and to enhance the living resources of these nationally significant estuaries.

These goals are to be achieved through collaborative efforts called comprehensive conversation and management plans, CCMP's. The development of CCMP's is carried out by oversight committees called management conferences. A management conference consists of Federal, State and interstate agencies, as well as interested academic and scientific institutions, industries and citizens' groups, who are the stakeholders in the individual estuaries.

Through a consensus-building approach, the management conference establishes program goals and objectives, then identifies and selects the problems to be addressed in the CCMP and designs pollution control and resource management strategies to meet each objective.

Strong public support and commitment are needed to accomplish the actions needed in the CCMP. As we have seen in the implementation of the Chesapeake Bay and the Great Lakes programs, we need very strong public support to get this to happen.

Congress gave priority to 12 estuaries in the act. In the spring of 1988, the Agency convened management conferences for six of these estuaries: Albermarle-Pamlico Sound, Buzzards Bay, Long Island Sound, Narragansett Bay, Puget Sound and San Francisco Bay. By May 1988 EPA had received Governor's nominations for the remaining estuaries given priority consideration: Delaware Bay, Delaware Inland Bays, Galveston Bay, New York-New Jersey Harbor, Santa Monica Bay and Sarasota Bay. On July 18 the administrator convened management conferences for these six estuaries.

We will negotiate with all these estuary program plans for a 5-year program and conference. The critical issue, Mr. Chairman, is that the NEP is funded from two EPA sources: funds authorized to be appropriated under section 320 of the Clean Water Act with an authorization ceiling of $12 million and a construction grants set-aside for implementation of Section 320 activities—one-third of 1 percent of the construction grant appropriations. The key issue is that in fiscal year 1991 the set-aside program ends.

In fiscal year 1988 the NEP total funding, combining the two sources, is $12.7 million, and the President's request for fiscal year 1989 is $12.3 million. This level of funding and authorization is suf-

ficient to support the convened management conferences for the 12 congressionally designated priority estuaries.

I am concerned that without further congressional support, other estuaries will have a difficult time if they are nominated. One of the things I have seen in the Massachusetts Bay area is an innovative approach to funding the beginnings of a National Estuary Program, even though it has not been given that name.

Funds to support this program through 1990 will come from the Massachusetts Bay-Boston Harbor Trust Fund. Contributions to this recently established and innovative trust fund will come from the $1.6 million in Federal civil penalties that were assessed on the Commonwealth of Massachusetts for violations of the Clean Water Act. Mr. Delaney will talk about progress on that in a moment.

We strongly support the establishment of the Massachusetts Bay-Cape Cod Bay initiative. EPA Region I has played an active role in supporting this program by providing policy guidance, program oversight, support staff and limited funding. In addition, EPA Region I was instrumental in negotiating the establishment of the Massachusetts Bay-Boston Harbor Trust Fund. We anticipate continued involvement and support for the Massachusetts Bay-Cape Cod Bay initiative as it progresses.

You have asked me to identify the benefits that may result. We believe the initiative will benefit from the experiences of the Massachusetts Bay program and other programs. It should allow for the promotion of strong public support and political commitment which will be necessary to carry out the goals of the management program.

Official inclusion of the initiative in the NEP would, however, enable the use of federal consistency requirements and CCMP development authorities under Section 320 of the Clean Water Act.

Finally, EPA opposes inclusion of any estuary in the NEP without following the nomination process, as that process ensures state commitment to the success of the CCMP. The statute as drafted does not clearly indicate whether Massachusetts Bay/Cap Code is to be automatically included in the National Estuary Programs or be given priority consideration as has been given the other twelve estuaries.

This concludes my prepared statement. I would be happy to answer your questions at this time.

Mr. STUDDS. Thank you very much.

We go next to Mr. Richard Delaney, assistant secretary of the Executive Office of Environmental Affairs of the Commonwealth of Massachusetts.

Thank you again for coming.

Mr. DELANEY. Thank you, Mr. Chairman.

STATEMENT OF RICHARD DELANEY, ASSISTANT SECRETARY, EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS, COMMONWEALTH OF MASSACHUSETTS

Mr. DELANEY. I am here as assistant secretary of the executive office of environmental affairs of the Commonwealth of Massachusetts to strongly support the proposed legislation, H.R. 4883, the designation of Massachusetts Bay-Cape Cod Bay as an estuary of

national significance in the National Estuary Program. This designation will be central to our efforts to clean up and restore this area to its proper healthy condition.

I have submitted written testimony and will keep my oral remarks brief.

The case for such a designation as you propose in your bill could not be made any more dramatically than is being made now on the newsstands in every city across the country. Both Newsweek and Time magazine have cover stories today citing the terrible state of the quality of our marine waters. I have taken the liberty of making copies of those articles and, with your permission, Mr. Chairman, I would like to submit those for the record.

[A Newsweek article and a Time article submitted by Mr. Delaney can be found at end of hearing.]

Mr. DELANEY. Regarding Massachusetts Bay, the evidence is just as alarming. Having some of the Nation's oldest cities and towns situated along that particular area and having some of the most densely populated areas along Massachusetts Bay has resulted in decades of acute pressure on the natural resources.

Massachusetts Bay, Cape Cod Bay and Boston Harbor have been the repository of too much waste over too many years and the evidence is alarming.

I cite in my testimony the results of several studies: NOAA has shown the sediments in Boston Harbor to have some of the highest levels of PCB's, PAH's, DDT residues in the country, despite the fact that the production of DDT and PCB's has been prohibited since 1977.

An Environmental Protection Agency (EPA) study has indicated high levels of contaminants in parts of the lobsters in Quincy Bay, and there have been public health advisories against eating the tomalley from lobsters issued as a result. More recently, the Environmental Defense Fund has shown much of the nitrogen loading in marine waters is now attributed to air-borne pollution.

Yet despite these studies, there remains a lot of uncertainty and a tremendous lack of knowledge about what is happening in our coastal systems. We don't have a clear understanding of the linkage between toxics and public health. We know it is not good, but we are not sure about the causal relationships. We don't know about the impact of the pollution on the overall ecosystem itself. We have only a rudimentary understanding of how that system operates. We are just beginning to learn about other sources of pollution. In addition to point sources of pollution, the nonpoint sources of pollution are, in some cases, contributing as much as half the pollution load to marine waters and must be dealt with equally aggressively.

In Massachusetts we are fully engaged in the cleanup of Boston Harbor. The effort is going quite well, but it will take a tremendous amount of money and energy to bring it to conclusion.

We are gathering more information from the various studies associated with the cleanup, but there are still significant gaps in our knowledge. We have not designed those studies in such a way that they would provide a holistic, integrated understanding of the system. This is partially due to the fact that these studies typically are site specific, short term in nature and one dimensional.

What is needed is a more holistic integrated understanding of the system and the EPA National Estuary Program, as described by Mr. Davies, offers just that kind of opportunity.

We have also learned that we have not coordinated our science directly and closely enough with our managers and our decisionmakers. Another principle of a National Estuary Program is to promote that linkage between the scientists and the decisionmakers. Many of our current efforts are directed toward immediate solutions to treating pollution and do not address the reduction of sources of pollution nor developing long-term remedial efforts. We are now beginning to understand that in addition to building the secondary treatment plant in Boston Harbor and correcting the combined sewer overflows we must develop a more comprehensive strategy that includes education, research, monitoring, source reduction and innovative solutions. The National Estuary Program endorses these concepts.

We have already undertaken an effort in Massachusetts to create a similar program. The organizational structure, goals and membership will be announced soon.

We have also looked for other sources of funding. At 2 o'clock this afternoon, Governor Dukakis will sign a supplemental budget that will include a total of $2.425 million to be paid in fees and penalties for past transgressions of the Clean Water Act by the Commonwealth of Massachusetts; $2 million will stay in an environmental trust that is also being created by the Legislature of Massachusetts, and 1.6 million of those dollars will be dedicated to funding the first year or year-and-a-half of our Massachusetts Bay Program.

The reason your legislation is critical and official recognition by EPA of our effort as a Bays Program is essential is that we want to have this be more than a 1-year deal. It has to be a multiyear effort. We are hoping to have a strong $1 million to $1.5 million funding for 5 years to develop a truly comprehensive management plan for Massachusetts Bay. H.R. 4883 would provide the substantive and financial support that will assure our success.

I would also point out that section 5 of the bill gives the important legal authorization to set up such a trust fund to receive the fees rather than have them go into the U.S. Treasury at this time. So, again, I am here to strongly support H.R. 4883, thank you for your concern, and answer any questions you might have, Mr. Chairman.

[The statement of Richard F. Delaney can be found at the end of the hearing.]

Mr. STUDDS. Thank you very much.

Our next witness is Dr. Gordon Wallace, Associate Professor, Environmental Sciences Program, University of Massachusetts at Boston.

STATEMENT OF GORDON WALLACE, ASSOCIATE PROFESSOR, ENVIRONMENTAL SCIENCES PROGRAM, UNIVERSITY OF MASSACHUSETTS AT BOSTON

Mr. WALLACE. I wish to point out several observations that warrant concern. First of all, as many of you know, the Massachusetts

Bay-Cape Cod Bay-Boston Harbor System is confined within a semi-enclosed basin. Free exchange of water between the Bays and the adjacent waters of the Gulf of Maine is restricted by the presence of Stellwagon Bank along the eastern boundary of this embayment. This restricted exchange can be expected to enhance the accumulation and potential effects of any contaminants introduced into these Bays.

The current environmental quality of the harbor-bays system is another area that warrants concern. As my written testimony indicates, organic and inorganic contaminant concentrations in the sediments of Boston Harbor are among the highest observed anywhere. Concentrations of metals in the water column of Boston Harbor are 10 to 100 times those expected in a relatively clean coastal environment. There is no doubt that the biota of Boston Harbor have been severely affected by the presence of these contaminants. Winter flounder taken from the Harbor have one of the highest incidences of cancer observed. The physiological status of shell fish such as the soft-shelled clam *Mya arenaria* is extremely poor. This raises questions about their survival and propagation for the maintenance of the economic viability of this important resource if existing beds were open to active shell fishing, which most are not.

All of these observations on the environmental status of the Harbor are of concern because a large fraction of the contaminants entering the Harbor are probably reaching Massachusetts and Cape Cod Bays. We know the ecosystem of the harbor is severely impacted. We are not al all sure of the degree of impact on the ecosystems of Massachusetts and Cape Cod Bays. Analysis of sediments from these bays reveal concentrations of contaminants such as polycyclic aromatic hydrocarbons [PAHs] that are comparable to those observed in sediments from the New York Bight Apex.

Lobsters sampled in Salem Harbor have levels of PCB contamination equivalent to that we have observed in lobster collected near the Deer Island outfall, one of the major sewer outfalls in Boston Harbor. The impacts on seafood quality are, therefore, not necessarily limited to Boston Harbor, but may be widespread.

Water column concentrations of metals in Massachusetts Bay are two to three times what would be expected in clean coastal seawater. To raise the concentration of metals in a water body of that size is not a trivial task. It requires major inputs and/or long residence times of water in the bay. Unfortunately, neither the magnitude of the inputs or the residence time of water in the bays have been determined.

Another area of concern is how well we understand the current inputs of contaminants to the harbor-bay system. Discharge of sewage from Boston and other coastal communities is an obvious source. Boston has a well-documented history with respect to its sewage disposal problems. It should be recognized that the proposed new outfall will still represent, even with secondary treatment, a major source of contaminants to Massachusetts Bay.

However, sewage disposal is not the only source of contaminants to the bays. The Merrimack River, formerly one of the most polluted rivers in the country, discharges to coastal waters north of Massachusetts Bay, but, because of prevailing currents, the bulk of that

water and its contaminants enters Massachusetts Bay. Our estimates of the magnitude of this source suggests it may be as important as the current discharge of 500 million gallons a day of primary treated sewage from Boston Harbor. Clearly, the influence of the Merrimack River may be important, but, due to lack of adequate data, is largely unknown and undefined.

Atmospheric deposition is another potentially important source. Massachusetts and Cape Cod Bays are geographically situated such that they receive the atmospheric fallout of pollutants introduced into the atmosphere from the heartland of this country as well as from local sources in New England. We estimate the atmospheric sources of contaminants to be of a similar magnitude as the riverine sources. This is a very, very crude estimate, and is not made on the basis of actual measurements, but extrapolated from measurements made elsewhere. As a scientist, such speculation is inherently uncomfortable, but, in the absence of actual data, useful in estimating the potential importance of a suspected source. Clearly there is a need to test the validity of such estimates by obtaining the necessary data.

In the late 1970's and early 1980's, it was suggested that the source of PAH's to Massachusetts Bay is probably from urban runoff from the Boston metropolitan area via incorporation into the sediments of Boston Harbor and the subsequent transport of those contaminated sediments from the harbor into the bay. Again, evidence in support of this scenario is not of the degree we feel entirely comfortable with, but clearly there is enough evidence to suggest urban runoff is a major source of PAHs and probably other contaminants to Massachusetts and Cape Cod Bays.

Much of the above discussion of sources is based on speculation, and as such makes me, frankly, uncomfortable in making such statements when in good faith I know some of these estimates may be highly uncertain. Furthermore, until we have made the appropriate measurements, such estimates will necessarily remain highly uncertain.

How well do we understand how this system functions? In preparation for a multidisciplinary course on urban estauries offered at the University of Massachusetts at Boston, I conducted a library search to identify available data, published in scientific journals or in government documents, for a number of urban estuaries. The number of published references identified for Narragansett Bay was 288; for San Francisco Bay, 328; for Puget Sound, 324; for Chesapeake Bay, 1,010; and for Boston Harbor and Massachusetts and Cape Cod Bay combined, 61.

Furthermore, if one examines the nature of the 61 citations for the harbor-bay system, most are found to be of a narrow focus such as site-specific studies or, for example, a study of the biology of a given polychaete worm. In other words, most cannot be used as the basis for critical management decisions and the development of an intelligent strategy for handling environmental and socioeconomic problems of this embayment.

As a specific example of the type of problems likely to be encountered, I would like to note that the secondary outfall from Boston Harbor, which is going to be one of the largest in this country, will discharge large quantities of a nutrient-nitrogen to Massachusetts

Bay. The accelerated input of nutrients is of major concern in coastal waters, which in excess, can lead to potential eutrophication problems. The introduction of large quantities of nutrients to Massachusetts Bay from Boston's proposed new outfall is of particular concern because of existing evidence that oxygen concentrations in the deep waters of the Bay are depressed. Indeed concern over low oxygen concentrations in Massachusetts Bay was one of the reasons the 301th waiver application was denied for Boston. Secondary treatment does not remove large quantities of nitrogen. In fact, there have been generic arguments made in the literature that secondary treatment, under some conditions, may be more deleterious than primary treatment with respect to exacerbating potential eutrophication of the receiving waters.

I suggest that we have much to learn in order to achieve a fundamental understanding of the functioning of the Boston Harbor, Massachusetts Bay and Cape Cod Bays system that will provide more satisfactory solutions to specific problems such as the degree of treatment required to prevent coastal eutrophication.

We do not yet understand the basic physical, chemical and biological processes occurring in Massachusetts and Cape Cod Bays. The need for this information is critical. For example, unless we know the residence time of water in this system, we cannot begin to estimate what fraction of the contaminants introduced into the Bays will be transported offshore or be retained within the bay environments.

I would argue that before making billion dollar management decisions, we do our homework and understand the environmental and socio-economic framework within which we are making these decisions. Is the investment of hundreds of millions of dollars in a sewage plant contributing a small fraction of the contaminants entering the Bays more beneficial than applying those funds to pretreatment or other control programs to reduce contaminant loading in the Merrimack River and other sources along the coast? I think, from a scientific perspective, we don't have the information we need to make these kinds of decisions with an acceptable degree of certainty. The Massachusetts Protection Act will provide the means to reduce the level of uncertainty in making such decisions to a more acceptable level.

[The statement of Mr. Wallace can be found at end of hearing.]

Mr. STUDDS. Thank you. Finally, we have Mr. Jay R. Kaufman, Executive Director of the Massachusetts Bay Consortium.

Mr. KAUFMAN. Thank you, Mr. Chairman.

STATEMENT OF JAY R. KAUFMAN, EXECUTIVE DIRECTOR, MASSACHUSETTS BAY CONSORTIUM

Mr. KAUFMAN. As I flew over Chesapeake Bay this morning on my way into Washington, I was reminded of Abraham Lincoln's postulate that "The legitimate object of government is to do for a community of people whatever they need to have done, but cannot do at all in their separate and individual capacities."

When Congress moved to protect and enhance the environmental quality of the Chesapeake, it took a threatened and valuable national resource and called on and empowered the peoples of this

region to come together to do what they had failed to do in their separate and individual capacities.

The result is new hope for the bay, a new sense of community for its residents, and a federal program which, with a modest investment of dollars, has generated new knowledge and understanding, wiser management, and a bay that will repay the investment many times and for decades in fish catch, tourism and public health.

We are here today to ask that you do it again. We are here to ask you to join us now in investing in the future of Massachusetts Bay.

We have in recent decades witnessed the gradual decline and increasingly fragile condition of our coastal waters, as we have heard, and as you know. For years the debate about environmental quality generated more heat than light. There was much we didn't know or understand, and even more that we didn't do.

Happily we are not here today to ask you to bail us out. We are here to report a window of opportunity.

The citizens of Massachusetts are ready and eager for the bill before you. We have read and heard about the pollution of Boston Harbor and the threats to Massachusetts Bay. Hardly a day goes by without some local press coverage, and we are certain to see national attention between now and November. We are excited about the creative resolution of the EPA's lawsuit against the state for violation of the Clean Water Act and about the Environmental Trust Fund that resulted from that action.

We are eager to launch the Massachusetts Bay-Cape Cod Bay Program to invest funds from the trust to better understand and clean up the harbor and bay and to begin to protect them for our children. The program hasn't even been publicly announced yet, but we already have a large and motivated citizens' advisory committee chafing at the bit.

We also have launched an entirely volunteer-driven citizens' monitoring program to take water and sediment samples in an effort to collect baseline data and to draw public attention to our scientific uncertainty. We are also increasingly and ever more painfully aware that our sewer rates and taxes will soar as we strive to end decades of pollution and work to restore our badly assaulted coast. The protection and enhancement of the environmental quality of Massachusetts Bay is in our thoughts, our hearts and our budgets.

We are not alone in our concern. With Harvard University, MIT, the University of Massachusetts at Boston, and Woods Hole Oceanographic Institution—among others—close at hand, we have no shortage of academic talent to address the myriad scientific, engineering and management questions that confront us. If there is a lot we don't know, it is because we haven't funded a very eager and qualified research community.

I have also seen that the corporation and foundation community in Massachusetts is poised to support efforts to better understand and manage Massachusetts Bay.

The Massachusetts Bay Consortium has for the past 4 years sought to bring focus to the science and policy of Boston Harbor and Massachusetts Bay, and we have been able to do so because of generous grants from local businesses and foundations.

In part, these grants were intended as seed money, as a challenge to the state and federal governments to dedicate resources to the bay. In part, too, they were a challenge to the many separate and independent towns and government agencies to work together for coordinated action and comprehensive planning. The Environmental Trust Fund that Mr. Delaney discussed is one response to those challenges. The bill before you is another.

Why are we asking you to join us as partners in our efforts to save the harbor and save the bay?

For one, the challenges are so great that it is hard to imagine how we can begin to meet them without federal funds to complement the citizen energy, grants, state allocations and pool of talent that we represent before you today. For another, incorporating Massachusetts Bay into the existing federal program allows us to build on the successes that Congress has already funded, avoid some of the pitfalls already experienced and add to the growing library of information about particular bays and bays in general.

We are asking for this partnership, too, because our newly undertaken efforts to understand and manage the coast are as fragile as the environment we are trying to restore and protect.

A strong tradition of home rule makes regionwide action difficult in Massachusetts. Soaring rates will bring intense pressure to relax our environmental protection and save money for today, even at the expense of tomorrow.

Today's infamous Boston Harbor crisis is testimony to the difficulty of looking beyond our own time and place to plan for the future. That crisis is of our own making. We simply didn't begin the planning that could have averted the breakdown of our old water and sewer system or the research that would have allowed us to design a new one.

If we fail to dedicate research and planning resources now, we will pass on to our children a new Massachusetts Bay crisis, and they will face their challenge no better prepared with information and insight than we. I hope history will record that we had the courage and foresight to plan and act for the future, and I hope and trust that this Congress will help us take the first steps.

Thank you again for the opportunity to appear before you.

I will be happy to answer any questions.

Mr. STUDDS. Thank you, Mr. Kaufman.

Mr. STUDDS. This is one of those rare times when there is unanimity here.

If we are not pressed for time, I would take at least 15 minutes to discuss this with you.

This weekend I was catching blue fish—sizable ones, I must say. This morning I flew over the entirety of this area and in the course of a 20-minute flight saw commercial and recreational fishing vessels, lobstering vessels, operating out of Deer Island, if one can imagine, and a number of whales, all of that in a 15-minute flight.

Mr. Wallace, you frightened me a little bit. We are all hearing estimates of what we don't know here. This is a positively Socratic committee here on the information we don't know. You frighten me when you say the $6 billion we are planning to spend may actually make it worse.

You did not mean to say that, did you?

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Mr. WALLACE. No, not really worse. But improving the quality of the discharge from the existing primary discharge to secondary treated effluent by construction of the new Boston sewage treatment facilities is not going to make all the problems go away, and in particular may not significantly improve its quality with respect to the discharge of nutrients, a critical class of "contaminants".

Mr. STUDDS. Six quadrillion is obviously not enough.

Mr. WALLACE. It depends how you need it. I think if we had done our homework——

Mr. STUDDS. If we play the game of what could have been done a long time ago, we would all go mad in this estuary and many others, I am afraid.

Is there any negative to our proceeding with this bill, aside from the fact I assume we all agree that the single most difficult thing will be the ways to apply this funding, both here and in the other estuaries around the country.

Are there any arguments of substance against proceeding with this legislation at this point?

Mr. KAUFMAN. I would not make any.

Mr. DELANEY. The effort underway now is modeled closely on the EPA Bays Program, and I think it would certainly fit any criteria that would be established by EPA for judgment as to whether or not it should be a national estuary program.

We certainly do want to have that kind of recognition and potential funding that would come from it.

Mr. STUDDS. It sounds like the state has something of a head start here, both with respect to beginning the studies, coordinating the studies, and certainly with the trust fund you are on your way, it seems to me.

Mr. DELANEY. That is correct.

Mr. STUDDS. I am going to have to cut this shorter here than I would otherwise like to do. We have to go and try to save the striped bass as well as the water in which they swim.

Before we recess, would anyone want to add anything as far as the potential impact of the legislation?

I think each of you described why it is an approach to a very complex problem which is going to be troubling people for a long time to come.

Mr. Wallace.

Mr. WALLACE. One thing that does set this particular embayment apart from others is the level of ignorance and the level of impact, both on the extreme sides. When you have those two in partnership, then you do run the risk of mismanagement.

Mr. STUDDS. It must be exciting in academia to find an understudied subject.

Mr. Davies.

Mr. DAVIES. Besides Boston Harbor, there are a number of estuaries that have been nominated, by Governors who also are concerned about their estuaries, and which are of national importance in many ways.

I am concerned at the authorization level the Congress has put on this, that if we maintain that authorization level and try to run more than the 12 we have currently in the program, that we will

in fact stretch the program out and find that we are trying to do too much with too small resources.

Mr. STUDDS. Your concern is based on the assumption that things will remain as they have been here. There is at least the arguable possibility that we may be in the hands of folks who attribute at least some trick to the waters of the Massachusetts Bay. These are the waters where the Mayflower Compact was written. It is national. It is a source of concern to everybody.

I appreciate the extent to which you each in your own way have contributed to the case of this legislation in these waters and also outlined the way it fits into a national problem in a national pattern.

I wish it were unique, that we had only one estuary to worry about. I guess it is of more than passing symbolism that Time and Newsweek have chosen this particular week once again to headline what this Subcommittee has been focusing on in the course of the Congress. To use the favorite adverb of the city, next year there will be a comprehensive attack on these problems rather than the agencies here to deal with them.

Thank you all very much.

The Subcommittee stands adjourned.

[Whereupon, at 1:45 p.m., the subcommittee was adjourned.]

[The following was submitted for the record:]

I

100TH CONGRESS
2D SESSION

H. R. 4883

To amend the Federal Water Pollution Control Act to include Massachusetts Bay, Massachusetts, in the National Estuary Program.

IN THE HOUSE OF REPRESENTATIVES

JUNE 21, 1988

Mr. STUDDS (for himself, Mr. MOAKLEY, Mr. CONTE, Mr. MAVROULES, Mr. ATKINS, Mr. MARKEY, Mr. DONNELLY, and Mr. FRANK) introduced the following bill; which was referred jointly to the Committees on Public Works and Transportation and Merchant Marine and Fisheries

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A BILL

To amend the Federal Water Pollution Control Act to include Massachusetts Bay, Massachusetts, in the National Estuary Program.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Massachusetts Bay Protection Act of 1988."

SEC. 2. DEFINITION.

(a) For purposes of this Act, the term "Massachusetts Bay" includes Massachusetts Bay, Cape Cod Bay and Boston Harbor, consisting of an area extending from Cape

Ann, Massachusetts south to the northern reach of Cape Cod, Massachusetts.

SEC. 3. FINDINGS AND PURPOSE.

(a) FINDINGS.—The Congress finds and declares that:

(1) Massachusetts Bay comprises a single major estuarine and oceanographic system extending from Cape Ann, Massachusetts south to the northern reaches of Cape Cod, encompassing Boston Harbor, Massachusetts Bay and Cape Cod Bay;

(2) Several major riverline systems, including the Charles, Neponset and Mystic Rivers, drain the watersheds of eastern Massachusetts into the Bay;

(3) The shorelines of Massachusetts Bay, first occupied in the middle 1600's, is home to over 4 million people and supports a thriving industrial and recreational economy;

(4) Massachusetts Bay supports important commercial fisheries, including lobsters, finfish, and shellfisheries, and is home to or frequented by several endangered species and marine mammals;

(5) Massachusetts Bay also constitutes a important recreational resource, providing fishing, swimming and boating opportunities to the region;

(6) Rapidly expanding coastal populations and pollution pose increasing threats to the long-term health and integrity of Massachusetts Bay;

(7) While the cleanup of Boston Harbor will contribute significantly to improving the overall environmental quality of Massachusetts Bay, expanded efforts encompassing the entire ecosystem will be necessary to ensure its long-term health;

(8) The concerted efforts of all levels of government, the private sector and the public at large will be necessary to protect and enhance the environmental integrity of Massachusetts Bay; and

(9) The designation of Massachusetts Bay as an Estuary of National Significance and the development of a comprehensive plan for protecting and restoring the Bay may contribute significantly to its long-term health and environmental integrity.

(b) PURPOSE.—The purpose of this Act is to protect and enhance the environmental quality of Massachusetts Bay by providing for its designation as an Estuary of National Significance and by providing for the preparation of a comprehensive restoration plan for the Bay.

SEC. 4. DESIGNATION AS ESTUARY OF NATIONAL SIGNIFICANCE.

Section 320(a)(2)(B) of the Federal Water Pollution Control Act (33 U.S.C. 1330(a)(2)(B)) is amended by inserting "Massachusetts Bay, Massachusetts (including Cape Cod Bay and Boston Harbor);" after "Buzzards Bay, Massachusetts;".

SEC. 5. FUNDING SOURCES.

(a) In order to supplement the funds authorized under section 320 of the Federal Water Pollution Control Act (33 U.S.C. 1330), the Administrator of the Environmental Protection Agency and the Governor of Massachusetts are hereby authorized to accept funds derived from fines, penalties or settlements paid in conjunction with efforts to comply with the Clean Water Act by the Commonwealth of Massachusetts to finance activities pertaining to Massachusetts Bay undertaken pursuant to section 320.

(b) Within one year of enactment, the Administrator and the Governor shall undertake to identify and make available other sources of funding to support activities pertaining to Massachusetts Bay undertaken pursuant to or authorized by section 320 the Clean Water Act, and shall make every effort to coordinate existing research, monitoring or control efforts with such activities.

STATEMENT BY THE HONORABLE ROBERT W. DAVIS (R.-MICH.) AT THE JOINT SUBCOMMITTEE HEARING ON H.R. 4883: JULY 26, 1988.

THE NATIONAL ESTUARY PROGRAM CODIFIED BY SECTION 317 OF THE WATER QUALITY ACT OF 1987 IS VERY SIMILAR TO THE EPA GREAT LAKES PROGRAM, WHICH HAS BEEN SUCCESSFUL IN TACKLING SOME OF THE POLLUTION PROBLEMS PLAGUING THE LAKES. HOWEVER, WE MUST RECOGNIZE THAT INCLUSION IN THE NATIONAL ESTUARY PROGRAM IS FAR FROM A PANACEA FOR ALL THE POLLUTION WOES FOR ANY BODY OF WATER. THE FACT THAT THE STATE OF MASSACHUSETTS HAS BEEN SUBSTANTIALLY FINED BY EPA FOR CLEAN WATER ACT VIOLATIONS ILLUSTRATES THAT THE STATE MUST ALSO TAKE RESPONSIBILITY FOR ENSURING THAT ITS COASTAL WATERS AND SHORES ARE PROTECTED.

I LOOK FORWARD TO HEARING MORE ABOUT EPA'S WORK IN IMPROVING OUR ESTUARINE WATERS AND WELCOME OUR WITNESSES.

# # # # # #

RWD:LPM

STATEMENT OF
TUDOR T. DAVIES
DIRECTOR, OFFICE OF MARINE AND ESTUARINE PROTECTION
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
SUBCOMMITTEE ON OCEANOGRAPHY AND THE
SUBCOMMITTEE ON FISHERIES AND WILDLIFE CONSERVATION
AND THE ENVIRONMENT,
OF THE
COMMITTEE ON MERCHANT MARINE AND FISHERIES,
U.S. HOUSE OF REPRESENTATIVES

July 26, 1988

Good afternoon. I am Tudor Davies, Director of the Office of Marine and Estuarine Protection (OMEP) in the Office of Water at the U.S. Environmental Protection Agency (EPA). The OMEP administers and oversees the National Estuarine Program. I would like to address my comments to the concerns raised in your letter of invitation; the range of pollution problems facing Massachusetts Bay/Cape Cod Bay, the degree to which these problems are currently being addressed, the benefits of participation within the National Estuary Program, and the liklihood of securing funding in the future.

The litany of problems impacting Boston Harbor and Massachusetts Bay/Cape Cod Bay is not new. Major pollutant discharges into the Bay include municipal waste, sewage sludge, and combined sewer overflows. Other activities that affect the Bay include dredging, waste disposal, residential and industrial development, and agriculture. Elevated levels of PCBs, PAHs, and metals are present in the sediments of Boston Harbor and its

tributaries. In certain "hot spots", sediment concentrations of these chemicals are among the highest in the world.

The pollution problems in Massachusetts Bay are the result of long term loadings of pollutants from these industrialized urban areas. Lobster taken from Boston Harbor suffer from shell and black gill disease while winter flounder exhibit a high incidence of fin rot and neoplastic lesions. A recent study by EPA found similar conditions and incidences of disease in Quincy Bay. Along the coast of Massachusetts Bay and Cape Cod Bay, productive shellfish areas are closing due to bacterial contamination. The Massachusetts Department of Health recently issued a dual human health advisory regarding: (1) the consumption of lobster tomally taken from urban embayments throughout the Bay, and, (2) the consumption of lobster, white flounder, and clams from the Harbor by sensitive populations (women of child bearing age and children under twelve).

The Massachusetts Water Resources Authority is in the process of a clean up program which includes new wastewater treatment and sludge processing facilities, the capture and treatment of overflow sewage during rainfall events, renovations of the sewers to eliminate leaks, and, reduction of toxic discharges to the sewer system. The new primary treatment plant will be completed and permanent sludge facilities will begin operations by 1995. Secondary treatment facilities will be operational by 1999.

By 1991, interim sludge facilities will be completed, ending the discharge of sludge into the Harbor. Other municipal dischargers into the Bay are in the process of up-grading to secondary treatment.

In 1987, Congress amended the Clean Water Act, formally establishing the National Estuary Program (NEP). The NEP is a nation-wide demonstration program targeting selected estuaries of national significance that are threatened by pollution and population pressures. The purpose of the NEP is to protect and improve the water quality and to enhance the living resources of these nationally significant estuaries. These goals are to be achieved through collaborative efforts called comprehensive conservation and management plans (CCMPs). The development of CCMPs is carried out by oversight committees called management conferences. A management conference consists of federal, state, and interstate agencies, as well as interested academic and scientific institutions, industries, and citizens groups. Through a consensus building approach, the management conference establishes program goals and objectives, then identifies and selects the problems to be addressed in the CCMP, and designs pollution control and resource management strategies to meet each objective.

Congress required EPA to give priority consideration to twelve estuaries. In the spring of 1988, the Agency convened management conferences for six of these estuaries; Albermarle/ Pamlico Sound, Buzzards Bay, Long Island Sound, Narragansett Bay,

Puget Sound, and San Francisco Bay. By May, 1988, EPA had received governor's nominations for the remaining estuaries given priority consideration: Delaware Bay, Delaware Inland Bays, Galveston Bay, New York-New Jersey Harbor, Santa Monica Bay, and Sarasota Bay. On July 18, the Administrator convened management conferences for these six estuaries.

The NEP is funded from two EPA sources: funds authorized to be appropriated under Section 320 of the Clean Water Act with an authorization ceiling of $12 million dollars, and a Construction Grants set-aside for implementation of Section 320 activities (1/3 of 1% of the Construction Grant appropriations). In FY 1991 as the Construction Grants set-aside ends the States will be able to continue to provide funding for the NEP under its EPA-capitalized State Revolving Fund pursuant to Title VI of the Act.

In FY 1988, the NEP total funding, combining the two sources, is $12.7 million and the President's request for FY 1989 is $12.3 million. This level of funding and authorization is sufficient to support the convened management conferences for the 12 congressionally designated priority estuaries.

This spring EPA Region I and the State began to look at environmental problems in Massachusetts Bay/Cape Cod Bay and to develop a management program which was modelled after the NEP. Funds to support this program through 1990 will come from the Massachusetts Bay - Boston Harbor trust fund. Contributions to this recently established and innovative trust fund will come

from the $1.6 million dollars in Federal civil penalties that were assessed on the Commonwealth of Massachusetts for violations of the Clean Water Act.

We strongly support the establishment of the Massachusetts Bay/Cape Cod Bay initiative. EPA Region I has played an active role in supporting this program by providing policy guidance, program oversight, support staff, and limited funding. In addition, EPA Region I was instrumental in negotiating the establishment of the Massachusetts Bay - Boston Harbor trust fund. We anticipate continued involvement and support for the Massachusetts Bay/Cape Cod Bay initiative as it progresses.

You have asked me to identify the benefits that may result by including the Massachusetts Bay/Cape Cod Bay initiative within the NEP. As it currently exists, the initiative will be able to draw from the experiences of the Chesapeake Bay, the Great Lakes, and the National Estuary programs. Also, since the management program is modelled after the NEP, it should allow for the promotion of strong public support and political commitment which will be necessary to carry out the goals of the management program. Official inclusion of the initiative in the NEP would, however, enable the use of federal consistency requirements and CCMP development authorities under Section 320 of the Clean Water Act.

Finally, EPA opposes inclusion of any estuary in the NEP without following the nomination process as that process ensures State commitment to the success of the CCMP.

This concludes my prepared statement. I would be happy to answer your questions at this time.

TESTIMONY OF
RICHARD F. DELANEY

ASSISTANT SECRETARY OF ENVIRONMENTAL AFFAIRS
COMMONWEALTH OF MASSACHUSETTS

BEFORE THE
SUBCOMMITTEE ON FISHERIES AND WILDLIFE
CONSERVATION AND THE ENVIRONMENT OF
HOUSE MERCHANT MARINE AND FISHERIES COMMITTEE

I am Richard Delaney, Assistant Secretary of the Executive Office of Environmental Affairs and Director of the Coastal Zone Management Program. I appreciate this opportunity to express the views of the Commonwealth of Massachusetts on Congressman Gerry Studd's bill (H.R. 4883) to include the Massachusetts Bay (including Boston Harbor and Cape Cod Bay) in the National Estuary Program. The Commonwealth of Massachusetts strongly supports this bill and urges the committee to report it favorably.

Historically, some of the oldest settlements in America are along the shores of the Massachusetts Bay coast, e.g. Plymouth, Gloucester, Salem, Marblehead and Boston. These coastal ports became the repository for mankind's wastes, both human and industrial. In early colonial days, these coastal towns supported fisheries and trades which gave way to textiles and manufacturing in the 19th century and electronics and other technologically oriented industries in the 20th century. With these historical changes in use, so have come changes in the nature and the levels of pollutants and contaminants entering the system. We have evolved from eliminating typhoid a waterborne, sewerage related disease to attempting to regulate some of the 60,000 man-made chemicals, most of which end up

in the ocean. We discharge over 500 million gallons of sewerage per day (MGD) into northern Massachusetts Bay from the greater Boston area alone and an additional 50-75 MGD from cities and towns to the north.

The extent to which we have abused our nearshore waters was alarmingly evident in a recent National Status and Trends report released by the National Oceanic and Atmospheric Administration (NOAA) which showed Boston and Salem Harbors were among the most polluted urban estuaries in America. Chemicals identified in high concentrations in the sediments are polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and DDT residues. Some PAHs are known mammalian carcinogens and are associated with diseases of bottom feeding fish; PCBs may also be carcinogens, and PCBs and DDT residues are shown to adversely affect reproduction of marine biota and mammals. High levels of coprostanol, a steroid related to sewerage sludge and Clostridium perfringens spores, a bacteria indicative of human wastes were also in high concentrations suggesting that some portion of the observed contaminant loading is related to sewerage entering the system.

These and other pollutants, e.g. heavy metals, nutrients, other pathogens and other organic materials are not just confined to Boston and Salem Harbors, but are found in higher concentrations than would be expected in sediments of Massachusetts Bay, particularly the northern section. Contaminants enter the Bay from point sources of discharge, such as effluent pipes of wastewater treatment facilities, combined sewer overflows, and industrial discharges, and nonpoint sources such as, road runoff, overland flow and atmospheric input. Recent studies have indicated a freshwater plume from the Merrimac River, originating outside the system, flows into the northern section of Massachusetts Bay likely adding additional contaminants to the system. Calculations of pollutant loading into the system are higher per unit area than the New York Raritan estuary, long considered to be the most contaminated estuary in the country (Boehm, 1985,). NOAA Estuary of the North: Boston Harbor and Massachusetts Bay.

While urban harbors and urban land use have affected northern Massachusetts Bay, the southern portion, Cape Cod Bay is facing unprecedented development pressures that are straining the capacity of sewerage systems and increasing septic loading, road runoff and other sources of pollutant loading. We have little documentation for the cumulative effects on nearshore waters when we modify our landscape from fields, woods and agricultural lands to residences, shopping centers and condominiums with concommitent increases of parking lots and roadways.

However, we have some clear signals that the system is deteriorating. Shellfish beds closures on Cape Cod have increased several fold over the last few years and an additional 1200 acres have been closed this year bringing the total to approximately 7200 Acres. From a recent study in Buzzards Bay, the data strongly suggest that much of the increased coliform counts, the bacterial standard on which shellfish beds are closed, result from road runoff and from bacterial refuges in the system such as beach wrack. This year there were dramatic increases in closures due to red tides. Thus, both in the urban harbors such as Salem, Boston and Quincy Bay and in areas with septic systems, there are strong indications that the nearshore waters are suffering from increased use of marine waters as repositories for man's wastes.

A recent workshop by the Technical Advisory Group of the Executive Office of Environmental Affairs reviewed our current knowledge of the amounts and types of contaminant input into Massachusetts Bay from a variety of sources. Although point sources of discharge are a major contributor, other less well-documented sources may be of equal or greater importance for particular contaminants. This exercise pointed out areas where more specific information is needed. A recent press release by the Environmental

Defense Fund suggests that 25% - 30% of nutrients entering the Chesapeake are from atmospheric input. Because nutrient loading into Massachusetts Bay is of concern, a similar study is warranted for Massachusetts Bay.

A recently released study by the U.S. Environmental Protection Agency (EPA) has related contaminant levels in fish and shellfish to high levels of risk to humans. Levels of PCBs in lobster tomalley (hepatopancreas or liver tissue) was well in excess of 2 parts per million (PPM), the current U.S. Food and Drug Administration's (FDA) advisory level, resulting in the Commonwealth banning consumption of lobster tomalley. Furthermore, it was recommended that women of child bearing age and children under 12 not consume more than a few meals of Quincy Bay seafood a year due to high (but not above FDA limits) levels of contaminants in muscle of winter flounder and lobster.

There are three important aspects to this study. First, PCBs have not been manufactured since 1977, but are still bioavailable. Secondly, because of the uncertainities associated with the risk assessment methodology and the assumptions made, the link between contaminants in the system and human health risks are poorly understood. Nonetheless, this study's recommendations adversely affected fish sales, even though most of the fish at markets comes

from offshore where contaminant levels in edible portions are hundred fold less. Thirdly, we are only beginning to identify the effects of contaminants on the ecosystem (relative to our level of knowledge of effects on human health).

The Commonwealth is committed to improving water quality. It is estimated that $6.1 billion will be spent over the next 8 to 10 years to upgrade the greater Boston sewerage treatment facility from primary to secondary treatment and to upgrade several combined sewer overflows. Similar commitments are being made to upgrade sewerage treatment facilities in other cities and towns, e.g. Lynn, Swampscott, and the South Essex Sewerage District, some of which are already underway with planning and/or construction activities. Concerns about the lack of catchbasins on state highways has resulted in a recent bill that provides support for construction of facilities to improve the water quality from road runoff.

Despite the good intentions, thoughtful designs and millions of dollars spend in environmental studies and compliance monitoring, these efforts have failed to provide an integrated, holistic understanding of the system. Most of the environmental studies required by the Commonwealth and the federal government, address site

specific and usually short-term problems and issues. What is needed is an opportunity to obtain and better utilize information on environmental sensitivity and marine productivity of the nearshore water and apply this knowledge to protecting, restoring and maintaining a heavily polluted, highly complex system such as Massachusetts Bay.

One of the strengths of the National Estuary Program is its recognition of the need for a holistic approach to ecosystem management. This holistic approach recognizes the importance of joint state and federal sponsorship that involves local communities in the decision making process and implementation phase. As mentioned earlier, studies conducted in Massachusetts Bay have been disjointed and diffuse, in part, because there was no officially recognized group to oversee and integrate efforts. Furthermore, because many studies were designed to answer specific questions, broader issues, e.g. hydrographic studies which are very complex in Boston Harbor and the northern portion of Massachusetts Bay have been neglected. A recent example of the incompleteness of our understanding is the $5,000,000 spent on the outfall siting studies of the secondary treatment facility serving 43 communities and Boston. What emerged from these studies is the concensus that there is a general lack of understanding of the hydrographic conditions of

Massachusetts Bay, which limited intrepretation of results and the certainty of management decisions. The inability of the study to predict the fate and effect of nutrients and other contamiants in Massachusetts Bay from the outfall pipe with some degree of certainty has environmental and economic ramifications. There is concern that adding nutrients to the deeper waters of the Bay will create hypoxic conditions due to increased photosynthesis and increased biological oxygen demand from deeper waters which are already low in total dissolved oxygen. The Massachusetts Water Resources Authority was not required to conduct far-field ecosystem studies in meeting the statutory regulations. This is typical of most studies, except that more funding was available for this particular report.

Clearly what is needed is a process whereby the coordination of many small programs contributes to the understanding of the whole. A commitment to long term studies (a minimum of 5 to 10 years) which guarantees funding for a prolonged period of time will provide the opportunity to address some of the basic questions needed for interpreting data from a variety of studies. The National Estuary Program not only encourages this approach, but is structured in such a way that communication and joint cooperation are an integral part of the program. A second major strength of the National Estuary

Program is its emphasis on management. It is recognized that wise management decisions cannot be made without good scientific information. The National Estuary Program focuses on the identification of management questions and supports the scientific research and studies necessary to begin to answer these questions.

The Coastal Zone Management Office has been involved in the joint sponsorship of the Buzzards Bay Program, recently designated as an Estuary of National significance. Our participation in establishing and jointly staffing the program has provided a working knowledge of the benefits of these programs. These benefits include involvement of the scientific community, coordination of efforts with ongoing state and federally funded programs and a major effort to incorporate citizen involvement in all phases of the program, from planning through to implementation. This is needed for Massachusetts Bay.

About a year ago, David Fierra (Region I EPA) and I recognized the need for an integrated approach to managing Massachusetts Bay and discussed how this might be accomplished. From the outset we realized that good intentions and thoughtful organization of a Bays program structure were not sufficient. Funding of a "Bays" program is essential if the program is to accomplish its goals and provide

information in a timely fashion for managers of the ecosystem. At that time we discussed the possibility of using the money to be levied against the Commonwealth for "polluting " Boston Harbor to establish a Bays program for Massachusetts Bay (including Boston Harbor and Cape Cod Bay). Through negotiations with the federal government, an agreement was reached whereby $2,425,000 was levied against the state of which $425,000 will return to the general U.S. Treasury and $2,000,000 will be used to establish an Environmental Trust Fund. Of this two million dollars, $400,000 will be used for short term remedial projects and $1,600,000 will be used to establish a Massachusetts Bay/Cape Cod Bay program modelled after the National Estuary Program. The legislature has approved the funds and the governor is expected to sign the supplemental budget which approves these funds shortly.

Because of the language of the agreement, these funds need to be committed and obligated within a short period of time, which means that effectively 1 to 1 and a half years of funding is available. As a result, the focus of the program will be short term, unless some additional funds will be designated once these credit monies are committed and/or obligated. The Commonwealth recommends that additional funding through section 320 of the Clean water Act will provide funds to continue this program for an additional five years. The critical need for a holistic study of Massahcusetts Bay warrants this commitment.

Because continued support for the Massachusetts Bay program from the Environmental Trust Fund is uncertain, without 320 funds the long term future of the Massachusetts Bay program is unclear. The trust fund was conceived of as a mechanism for assisting all Massachusetts environmental programs and not specifically to support marine studies nor to commit to long term marine research and monitoring programs. Moreover, as yet, the organization of the trust fund has not gone through legal approval, presumably a necessary step before fund raising activities can begin. Although there is an agreement that an Environmental Trust Fund should be established, there is uncertainty as to how long it will be before it is functioning. It is clear, however, that any future funding of the Mass Bay/Cape Cod Bay program from the Environmental Trust will be at a significantly reduced level if at all. Funding from the National Estuary Program will assure the program does not sputter into existence and falter but will continue to sustain the momentum made possible by the $1,600,000 initial commitment.

In summary, I would like to reiterate the following points.

1. The level of pollution in the Massachusetts Bay ecosystem is among the highest in the country. In the northern section of Massachusetts Bay, pollutants from highly urbanized harbors include known carcinogens (e.g. PAHs), chemicals that are known to affect reproduction of marine biota and

others (e.g. PCBs), plus a variety of other chemicals such as heavy metals, nutrients, and organic materials. The Quincy Bay Study links contaminants with human health effects and resulted in a prohibition against eating lobster tomalley. In other areas of Massachusetts Bay, e.g. Cape Cod where land use is more suburban, shellfish bed closures have increased at an incredible rate. Based on the high levels of pollutants and contaminants, the observed detioration of the system and the complexity of the Massachusetts Bay ecosystem, the question to raise is not should Massachusetts Bay be part of the National Estuary Program, but why wasn't it included earlier.

2. The second point I'd like to emphasize is that current studies are focused on short term issues, and that the interpretation of results is limited by our general lack of understanding of the whole ecosystem highlighting the need for long term funding commitment to an integrated program. The two are inter-related.

3. Long term commitments to programs are essential for implementing long term plans. It has taken several hundreds of years to pollute Boston and Salem Harbors, it will take many years to redress the changes. Too often funding of projects and the study of their impacts are

limited by political time scales and the regulatory requirements (e.g. compliance monitoring and Environmental Impact Reports) rather than recognizing the longer term ecosystem ramifications. We have begun to recognize this, vis a vis the following examples: hundred year flood calculations are required for Wetland Protection Act decisions, the break at Chatham occurs approximately every 140 years, and the inclusion of sea level rise estimates in sewerage along the coast. The structure of the Bays programs encourages a process whereby the need for long term studies are recognized and supported by the public.

4. There is a need to commit between 1 to 1.5 million dollars per year to a Massachusetts Bay Program for a minimum of five years if we are to begin to understand the system and make wise management decisions regarding pollutant loading into the system. Funding for a Bays program for approximately 1 year will most likely be available through the credit monies levied against the Commonwealth. The Environmental Trust Fund that will be established faces organizational and legal processes that will of necessity delay its founding. That delay combined with the uncertainty of the extent of future funding from that Fund, leads me to recommend that the 320 funds of the Clean Water Act be used to support the Massachusetts Bay Program at the level of other major estuaries within the program.

I thank the committee again for allowing me to offer this testimony on behalf of the H.R. Bill 4883 to include Massachusetts Bay in the National Estaury Program. I hope that you will do so and recommend that funding at the level of other major estuaries be committed for at least 5 years.

Don't Go Near The Water

After decades of abuse, our coastal waters are dying. Is it too late to save them?

JIM MARKHAM

LEE FOSTER—PHOTOGRAPHERS/PEERS

ALAN BERGMAN—SOUTH BRONX P

ALAN BERGMAN

From sea to ... sea: *clockwise from top: Texas oil spill, Puget Sound sewage drain, Staten Island trash, Gulf Coast fish kill and medical refuse washed ashore in New York City*

With 9 million people competing for a place in the sun, New Yorkers are used to a little hassle—and a little mess—with their summertime fun at the beach. But this year is different for the past several weeks, beaches from Staten Island to the eastern Long Island resort towns have been intermittently shut down by a trickle of potentially hazardous medical waste—sutures, hypodermic needles, catheter bags and vials of blood. Where the debris came from is anybody's guess, and frustrated state and city officials have been quarreling about the likely source. But the beachgoing public, fearful of the fact that several of the mysterious blood samples have tested positive for AIDS, is observing New York's latest garbage crisis by staying home in droves.

New York's problem is by no means unique: along with a gruesome array of other garbage, hospital waste has floated ashore on beaches from Maine to Texas in the past year. Beach closings because of bacterial contamination are even more commonplace. This summer public-health authorities in locations from the New Jersey shore to San Francisco have been forced to suspend bathing because of sewage-plant breakdowns. Nearly a third of Louisiana's oyster beds are routinely closed because of pollution, and half the shellfish beds in Galveston Bay, Texas, are off limits to fishermen. Temporary or not, all these local pollution alerts underscore what responsible environmentalists say is now a full-blown national crisis: the wholesale contamination of U.S. coastal waters by millions of tons of sewage, garbage, toxic chemicals and other contaminants. Although the United States is now disposing of its human and industrial waste more carefully than ever before, there is mounting evidence that the ocean, like the land, is faring badly under the ecological stress imposed by man. It may well be, as New York City Health Commissioner Dr. Stephen Joseph suggested, that "the planet is sending us the message that there is a line beyond which we cannot go."

Drawing that line—establishing a tolerable balance between the needs of industrial society and the health of the biosphere—is what environmental regulation is all about. While the nation has made real progress in protecting its land, air and drinking water, most Americans are still largely ignorant of pollution's impact on the oceans and coastal waters they depend upon so heavily. That impact cannot be calculated with precision. But signs of progressive deterioration are sadly abundant along many of the nation's most beautiful bays, estuaries and seashores. Ocean pollution is not only apparent when bathing beaches are closed because of waterborne contamination. It is evident every time a shellfish bed is put off limits to clamming or oyster harvesting, and it is implicated when whole species of fish—the striped bass in the Hudson River, for example—are declared unfit for human consumption. Many environmentalists also blame pollution for the rising number of fish kills, whale kills and red tides that are becoming familiar events in coastal communities from Maine to California.

'Black mayonnaise': The problem for most landlubbers, of course, is that most of the effects of coastal pollution are hard to see. Bays and estuaries that are now in jeopardy—Boston Harbor, for example, or even San Francisco Bay—are still delightful to look at from shore. What is happening underwater is quite another matter, and it is not for the squeamish. Scuba divers talk of swimming through clouds of toilet paper and half-dissolved feces, of bay bottoms covered by a foul and toxic combination of sediment, sewage and petrochemical waste appropriately known as "black mayonnaise." Fishermen haul in lobsters and crab covered with mysterious "burn holes" and fish whose fins are rotting off. Offshore, marine biologists track massive tides of algae blooms fed by nitrate and phosphate pollution—colonies of floating microorganisms that, once dead, strangle fish by stripping the water of its life-giving oxygen.

Pollution problems of one degree or another can be detected virtually anywhere along the coastline of the continental United States. This is due partly to advances in

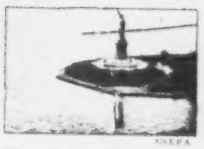
Where the Fish No Longer Jump

From Puget Sound to Chesapeake Bay, and along the Gulf Coast, too, once pristine inlets are in ecological ruins. A look at America's best-known bays shows that every one is in trouble, and that saving them won't be simple.

SETH RESNICK—PICTURE GROUP

Boston Harbor

Industrial waste and inadequate sewage treatment have turned the city's 50-square-mile harbor into the nation's largest cesspool. Local flounder suffer fin rot and tumors



U.S. E.P.A.

New York Harbor

Despite improvements, New York City's 14 sewage-treatment facilities still don't meet federal standards. The harbor is a rich stew of septic, chemical and industrial contaminants

DEAN—APERTURE

Chesapeake Bay

Pollution and salinity have decimated fish and oyster harvests in North America's largest estuary. PCB's and heavy metals have been detected in sediments and fish

the measuring methods used by modern science: trace elements of DDT, for example, are now identifiable in the sediment of many bays and estuaries, although DDT has been banned for nearly 20 years. But technology is only confirming what ecologists have been saying all along—that the slow buildup of chemical contaminants in coastal waters must have consequences, and that it is at best shortsighted to regard the ocean, as many shore dwellers do, as a place where pollution can be dumped out of sight and out of mind. "The environmental prophecies of the late '60s and early '70s are unfortunately coming to pass," says Les Kaufman, a research scientist at the New England Aquarium in Boston. "People have to look at [the environment] as an organism. That's not hippie talk. It's reality."

Growing costs: A primary cause of coastal pollution is human sewage, which continues to foul bays and beaches despite federal efforts to ban offshore disposal. Since Congress passed the Clean Water Act of 1977, federal, state and local agencies have spent more than $100 billion improving the nation's sewage systems to what EPA calls the "secondary treatment" level. (Secondary treatment means that 90 percent of all solid waste is removed from sewage effluent.) It can be argued that the money was well spent: more than half the nation's population now disposes of its sewage in ways the EPA deems safe, and the quality of many coastal and inland waterways—notably the Great Lakes—has improved substantially as a result (page 48). But maintaining current EPA standards is likely to cost as much as $400 billion more by the year 2000—and this time, unless Congress changes its mind, state and local governments will have to foot most of the bill.

There are gaping flaws in the facade of septic progress, however. *One of them* is the fact that the Clean Water Act did not require pollution controls on storm sewers. Storm sewers connect the numberless grates and drains on the streets of almost every city and town in America; they dispose of rainwater. It is a fact of urban life that storm sewers also collect large amounts of pollutants—gas, oil, antifreeze, fertilizer and pesticides—then deposit the resulting mess in the nearest waterway. Christine Reid, a Santa Monica, Calif., city councilwoman, blames Los Angeles-area storm sewers for much of the pollution that befouls Santa Monica Bay. "Many of us just aren't attentive to the things we don't see," Reid sighs. "The people sweeping dog doo in the gutter don't realize that their kids will be surfing in it."

Grease balls on the beach: By far the worst problem with offshore sewage pollution is the fact that some of the nation's biggest metropolitan areas have never quite complied with the Clean Water Act. New York (page 46) is a prime example; so is Boston. Despite the sparkling redevelopment of the Boston waterfront, Boston Harbor is one of the worst coastal cesspools in the nation. Three million people live within a 25-mile radius of the harbor, and nearly all the human and industrial waste of the metropolitan area winds up in its waters. The harbor bottom contains high concentrations of DDT and PCB's, a chemical compund that is widely used in electrical equipment and suspected of being a carcinogen. Local beaches are littered with grease balls, tampon applicators and the occasional condom—all of which are apparently released by the antiquated and overloaded sewage system.

At best, the Boston system offers what is politely known as "primary" treatment—which means that sewer sludge is separated from waste water, and then *both* are dumped into the harbor. "If that sounds unbelievable," says Paul Hauge of the Conservation Law Founda-

Staten Island flotsam: *U.S. park police with medical waste*

Gulf of Mexico

Oil spills, off-ship dumping, industrial discharge and sewage runoff have closed beaches, degraded wetlands, destroyed wildlife and threatened commercial fishing in the gulf.

VIDLER—AFTER IMAGE

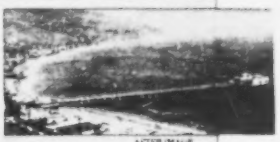
San Francisco Bay

Rapid development, and the diversion of streams and rivers that once flushed the bay, have fostered dangerous concentrations of a wide range of pollutants.

KREPS—APERTURE

Puget Sound

Discharge from mills and smelters has inundated the sound—and its marine life—with heavy metals and toxic chemicals. Some inlets have been designated hazardous sites by the EPA.



AFTER IMAGE

Santa Monica Bay

Sewage and uncontrolled storm runoff from fast-growing Los Angeles County have tainted the bay and its beaches; white croakers from the area are now inedible.

tion of New England, "it's because it is." At worst—after a heavy rainstorm, for example—the whole system breaks down and raw sewage, plus whatever is flushed off local streets, is channeled into the harbor through "combined sewer overflows." Boston is belatedly beginning to clean up its act—but only after local environmental groups took the local sewer authority to court. The authority must stop dumping sewage sludge into Boston Harbor by 1991, and the beaches should be free of garbage by 1995. Secondary treatment should begin by 1999, 11 years after the Clean Water Act deadline. Environmentalists think Boston Harbor will begin to recover sometime in the next century.

The seals of Eagle Harbor: No one is betting that industrial pollutants like PCB's will disappear. Boston Harbor is only one of many coastal waterways whose bottoms may have been permanently contaminated with chemical waste and toxic metals. Other areas with especially difficult toxic-waste problems include New York Harbor, parts of the Mississippi River estuary in southern Louisiana and parts of Galveston Bay. Three areas of Puget Sound, the vast inland sea that is the pride of the Pacific Northwest, are so heavily polluted they have been designated toxic-hazard sites on the EPA's Superfund cleanup list. The bottom sediments and tidal flats of Commencement Bay—an inlet bordered by oil refineries, chemical plants, pulp mills and a defunct copper smelter—are loaded with petrochemicals, copper, lead, zinc and arsenic. Nearby Eagle Harbor is so polluted that much of its rapidly diminishing population of English sole can no longer reproduce, and the area's harbor seals once registered one of the highest levels of PCB contamination ever recorded.

Bay-bottom contamination by heavy metals and organic chemicals poses an environmental double whammy. Many such pollutants become more concentrated as they travel up the food chain. The obvious conclusion is that fish from polluted waters should not be eaten. New York state officials, to cite just one example, warn consumers not to eat more than one serving per week of any fish taken in coastal waters, the Hudson River or Lake Erie, women of childbearing age and children under 15 are advised not to eat many New York state fish at all.

The other problem with contaminated bottom sediment is that there is no good way to get it out. Some pollutants, such as DDT and PCB's, are extremely long-lasting chemical compounds that have spread very widely in rivers, bays and tidal muck. Dredging the bottom only spreads them further, which is why environmentalists often oppose dredging projects for navigation or development. And though some officials now say polluted sediment can be "capped" with a layer of clean fill, that remedy is probably useful in only a few, relatively small problem areas.

Dead zone: Marine ecologists are equally concerned by what is known as "nonpoint" pollution of coastal waters. Nonpoint pollution is a grab-bag term that refers to all forms of unregulated runoff from the land. Its environmental threat comes chiefly

A Witch's Brew of Pollutants

Toxic, bacterial and nutrient contamination now affects virtually the entire coastline of the continental United States, and some bays and estuaries may be impaired for generations. A survey of man's inhumanity to nature:

POLLUTANT	SOURCE	EFFECTS
Nutrients	Fertilizers, sewage	Algae blooms; marine life destroyed
Chlorinated hydrocarbons: pesticides, DDT, PCB's	Agricultural runoff, industrial waste	Contaminated and diseased fish and shellfish
Petroleum hydrocarbons	Oil spills, industrial discharge, urban runoff	Ecosystem destruction
Heavy metals: arsenic, cadmium, copper, lead, zinc	Industrial waste, mining	Diseased and contaminated fish
Particulate material	Soil erosion, dying algae	Smothers shellfish beds, blocks light needed by marine plant life
Plastics	Ship dumping, household waste, litter	Strangles, mutilates wildlife; destroys natural habitats

SOURCE: NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

(though not exclusively) from silt and from nitrogen and phosphorous compounds used as fertilizers. These nutrients, which are not in themselves toxic, feed algae blooms which can gradually suck the dissolved-oxygen content from bays and inlets, choking off both plant and animal life. American farmers use enormous amounts of fertilizer on their crops, much of which is lost in runoff to the sea. Nutrient runoff may be contributing to the growth of a 3,000-square-mile "dead zone" near the mouth of the Mississippi River in the Gulf of Mexico. But farmers aren't the only culprits: in the metropolitan Northeast, says Dan Dudek of the Environmental Defense Fund, much of the fertilizer runoff can be attributed to millions of zealous suburbanites feeding their lawns.

Nonpoint pollution is now a problem in virtually every bay and estuary in the United States, and it is certain to get worse. It is made more acute by coastal development—the process of ditching, draining and filling wetlands that previously served both as breeding grounds for marine life and as filters for pollution from the land. At least half the nation's coastal wetlands have now been lost to "heiter-skelter" development, the EPA's Rebecca Hamner says. The long-term impact on fish, shrimp, crabs and other food sources can only be guessed at, but pollution from nitrogen and phosphorous compounds is already altering the balance of nature in some of the nation's most productive fishing grounds. Albemarle and Pamlico sounds, in North Carolina, are a case in point. Veteran crabbers like Gray Paul of Core Point, N.C., who has been fishing the Pamlico River for 20 years, say their catches have dropped by half in the past two years because the river's oxygen content has been depleted. More and more, Paul says, Pamlico Sound's blue crabs are coming ashore in a desperate search for oxygen. "Last night they were even climbing on top of the pier because of the dead water," he says.

The burden of nonpoint pollution is demonstrated all too well in Chesapeake Bay, one of the mid-Atlantic region's busiest waterways. Like other endangered estuaries, the Chesapeake has clearly bene-

The price of ocean dumping: *Shellfish with burn-spot disease*

New York's King-Size Sewage Problem

Churning up the algae-stained waters around New York City's 26th Ward sewage-treatment plant, a 325-foot sludge boat toots its horn and heads out to sea, brimming with 710,000 gallons of treated human waste. The tanker is part of a small fleet that plies the ocean 24 hours a day, annually releasing 8 million tons of sludge from New York City and eight neighboring sewer authorities into the Atlantic. Bobbing in gentle ocean swells, the boats slowly zigzag across a patch of ocean 106 miles offshore, releasing their cargo in jet-black plumes.

The boats haven't always traveled so far. For most of the past century, sludge barges and other haulers have made the waters off New Jersey and New York one of the world's most odious garbage dumps. Just 12 miles offshore, the ocean floor is littered with everything from rusting drums of low-level radioactive waste to turn-of-the-century rubble from subway tunnels and cholera-infested tenements. Shortsighted dumping of sewage, harbor dredgings and caustic industrial acids has fouled the beaches, killed millions of fish and laced once rich clam and oyster beds with deadly PCB's.

The federal Environmental Protection Agency officially banned sludge dumping as of 1981, but the New York-area sewage commissions successfully challenged the rule in court. Though they won the right to keep dumping, they eventually agreed to ferry the waste farther offshore and release it slowly to prevent high concentrations. Local officials, including New York Mayor Ed Koch, maintain that the current system poses no danger to aquatic life, but fishermen and environmentalists disagree. They say the old dump site is a virtual "dead sea" and they fear that dumping at the new site—located just off the continental shelf and in the heart of some of the nation's richest fishing grounds—will shatter a fragile marine ecosystem.

Little choice: Right or wrong, the sludge dumpers may be living on borrowed time. Congress, responding to pressure from fishermen and disgusted beach bathers, is poised do pass legislation in August banning all ocean sludge dumping by 1992. New York City officials are scrambling for ways to comply with the imminent ban, but none of the alternatives looks promising. Burning the waste in incinerators would add new pollutants to the region's already dirty air. And composting it on open land would require open space that the crowded area lacks. Either alternative would inspire bitter political protest and would be a huge financial burden. Given the volume of sewage involved—New York City produces 1.7 billion gallons every day—officials say they have little choice but to continue dumping some of the sludge at sea.

The problem isn't likely to be resolved before the turn of the century. But even if New York manages to stop dumping sludge into the ocean (as 200 other coastal communities already have), that alone won't save the nearby waters. The city's sewage system is so rickety that it shuts down during heavy rains—unloading raw sewage, 1.7 billion gallons at a time, directly into the harbor.

PETER MCKILLOP in New York

PETER FRYER

Overload: *Treatment plant*

fited from federal and state controls on point-source pollution from sewage and industrial plants. But fertilizer and pesticide runoff from upstream farms is still a major problem. In addition, according to a recent study by the Environmental Defense Fund, approximately 25 percent of the nitrogen pollution in the bay probably comes from acid rain—a finding that may have enormous implications for other coastal waters and for the continuing campaign to pass acid-rain legislation.

Curbing nutrient pollution is now a primary focus of government and private efforts to save the Chesapeake. Maryland, Virginia, Pennsylvania and the District of Columbia have agreed to an ambitious campaign to reduce the bay's nutrient levels by 40 percent by the year 2000. That will require billions of dollars in government funding and a small revolution in current soil-management techniques, such as creating buffer zones to control fertilizer erosion. Environmentalists like Ann Powers, vice president of the Chesapeake Bay Foundation, are "guardedly optimistic" about the future, although development pressures around the bay are still increasing. "The real question," Powers says, "is whether a fragile resource like the Chesapeake can exist in the middle of a megalopolis."

Cities by the sea: The question is no less relevant to the nation as a whole. Fully 70 percent of the U.S. population is already clustered within 50 miles of one coastline or another, and that concentration is increasing: America is gradually becoming Megalopolis-by-the-Sea. The consequences for coastal waters are obvious, and the federal government is stepping up its efforts to protect marine life and marine habitats. Under the Water Quality Act of 1987, EPA now has the authority to address nonpoint pollution. The same law established a national estuaries program to involve the federal government in state and local efforts to clean up the Chesapeake, the Great Lakes, Long Island Sound, Puget Sound, San Francisco Bay, Albemarle and Pamlico sounds, Narragansett Bay, R.I., and Buzzards Bay, Mass. Last week EPA expanded that list to include Santa Monica Bay, Galveston Bay, Sarasota Bay, Delaware Bay and New York Harbor as well.

The overriding point to shore-dwelling Americans is that marine pollution can no longer be dismissed as the special concern of scientists or environmental extremists. The costs of coastal contamination are large and very direct, as a recent study of New Bedford Harbor, Mass., by the National Oceanic and Atmospheric Administration suggests. Like the waters around Boston and New York, New Bedford Harbor is dying from a massive dose of toxic and nutrient pollutants. By NOAA's estimate, that pollution has already cost the town nearly $50 million—$2.1 million in lost revenues to local lobstermen, $1.9 million lost to the recreational fishing industry, $14.7 million in lost tourism and $30 million in reduced property values. The cost of averting further damage in New Bedford and nationwide, is likely to be very high—but Americans, on balance, have little choice but to do what still needs to be done.

TOM MORGANTHAU with MARK HOSENBALL in Washington, LUCY HOWARD in Boston, TED KENNEY in New York and bureau reports

'In Health There Are No Borders'

The New River stretches only about 80 miles, from the Mexican border into California's lush Imperial Valley, yet it holds the distinction of being the most polluted waterway on the continent. Great clumps of foam gush into the river from a large drain near its source in Mexicali and cascade across the U.S. border like tiny icebergs. Human feces float along, dumped directly from the city's antiquated sewer system. Bottles, bags and an occasional dead cat bob past, probably from Mexicali's municipal dump site, located on a tributary. Health experts have found 28 viruses—including typhoid, salmonella and polio—in the fetid waters, along with carcinogenic chemicals like chloroform and benzene. In some spots levels of fecal coliform bacteria have been measured at 5,000 times the U.S. standards for safe human contact.

There are similar horror stories all across the southern U.S. border: booming Mexican cities, unable to accommodate their growth, are spewing human and industrial wastes virtually unchecked into shared waterways. Every day, 8 million gallons of Tijuana's excess sewage inundate the Tijuana River, upsetting the ecological balance of California wetlands and forcing officials to keep two miles of beach near San Diego permanently closed. There are no sewage-treatment plants at all in Nuevo Laredo and Juárez, across the border from El Paso, Texas; human waste flows untreated into the Rio Grande. The rivers also contain hazardous chemicals, dumped by industrial facilities along the border. Environmentalists charge that at least some of the offenders are U.S.-owned *maquiladora* plants, taking advantage of Mexico's cheap labor and lax enforcement of environmental laws.

Dozens of commissions have convened since the 1940s to discuss the border pollution problems. But cleanup efforts remain pitifully scant. Under a recent $1.2 million pact, U.S. funds are now helping to restore Mexicali's sewage-treatment system. Still, the New River remains as contaminated as ever. California officials, meanwhile, are pressing Congress to help fund a $40 million "defensive pipeline" that would channel Tijuana's sewage back into Mexico before it threatens San Diego Bay. In the end, solving the problems will require much greater international cooperation—and a greater commitment of funds. "In health, there are no borders," sighs Jose L. Gonzalez, director of the health department in Laredo, Texas, where officials fear an outbreak of typhoid tracked in from the Rio Grande. "We're beginning to be scared about the powerlessness on our side."

New River: *A truck lies in the continent's dirtiest waterway*

Felled by pollutants that ride the winds: *Sampling the waters of Lake Ontario*

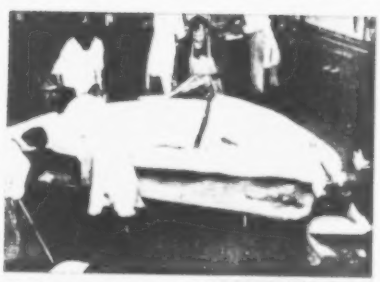
Toxins, Toxins Everywhere

The Great Lakes reel under an invisible assault

As marine scientists puzzle over the fate of the oceans, other researchers think they have seen the future—in the Great Lakes. Thirty years ago it seemed that the vast waters of the world's largest inland reservoirs could absorb anything and everything man dumped into them. But by the late 1960s Lake Erie was dying, and parts of the other four seemed poised to follow. A deluge of industrial effluents was poisoning the waves. Fish were dying in awesome numbers as the remains of algae that thrived on sewage and farm runoff depleted the water's oxygen supply. The mighty lakes, it turned out, were not infinitely resilient—and that points to a larger lesson. "I think the oceans will experience the same thing," warns Lyman Wible of the Wisconsin state division of environmental standards.

If the Great Lakes offer a cautionary tale, they also illustrate what money, technology and political will can accomplish. Since 1972 the United States and Canada have spent $9 billion to clean the lakes, primarily by building or improving sewage-treatment plants. On Lake Michigan's Green Bay, for instance, the 25 paper mills and municipal sewage systems that together disgorged some 400,000 pounds of organic waste a day 20 years ago now spew out just one-eighth that amount. And tougher federal laws have curtailed other "point sources" of pollution, such as factories and mines.

While the Great Lakes may look and smell better, they remain deeply troubled waters. "We are now dealing with the next generation of diffused, widespread and insidious toxic substances," says William Brah of the Center for the Great Lakes, a Chicago-based policy group. At least 400 hazardous chemicals—including PCB's, pesticides, cadmium and lead—are found in the lakes. Some have been there for decades, demonstrating that, contrary to the beliefs of a more innocent age, the lakes do not cleanse themselves, at least not quickly. PCB's, from electronics manufacturing, will remain in sediments for centuries. And the lakes continue to absorb a variety of "nonpoint" pollutants, such as pesticides and fertilizers from distant farms, lead from gasoline and petroleum products carried in runoff from cities.



A living 'toxic-waste container': *Examining a beached beluga*

Many insidious pollutants seem to ride the winds, something environmental scientists recognized only recently. PCB's, for example, have been detected in the air above Lake Superior near Duluth, even though they haven't been produced in the region in years. The fact that they're turning up in the lake water, not just on the muddy bottom, is further evidence that the winds are continually depositing the contaminants. Other pollutants in Lake Superior include toxaphene, an insecticide used mainly in the southern United States, and DDT, banned in the United States in 1972 but still used in Latin America. The bottom line, says Steven Eisenreich, a professor of environmental engineering at the University of Minnesota, is that "any chemical discharge in the Northern Hemisphere can find its way into the Great Lakes."

Fishy tumors. Typically, the chemicals are present in minute concentrations—they are often measured in parts per trillion in the water. But that is no reason for complacency. Plants and animals "bioaccumulate" the substances, increasing their concentrations with every step up the aquatic food chain. Since people eating lake fish would accumulate even higher concentrations of the chemicals, health authorities have banned carp fishing in Green Bay since 1984 and advise people not to eat large chinook salmon or rainbow trout. Although the health effects of the chemicals aren't clear, the lakes' denizens are hardly thriving on them. Tumors and other pollution-related deformities are widespread in the fish, for instance. And in the St. Lawrence River, which drains the lakes, bodies of beluga whales keep washing ashore. Riddled with PCB's, mercury, DDT and the carcinogen benzo-a-pyrene, "the whales should have signs on them saying 'toxic-waste container'," says geneticist Joseph Cummins of the University of Western Ontario.

The Great Lakes have shown that better sewage treatment and controls on factory effluents can clean up the most obvious trash and stench. Checking toxic chemicals, especially those borne by the wind, will be much harder—but every bit as important. As the lakes' history makes clear, even waters that stretch to the horizon will not absorb man's garbage without suffering, perhaps irreversibly.

WITH REPORTING BY
STEWART WEAVER in Toronto
and TIM PADGETT in Green Bay

COVER STORY

The Dirty Seas

Threatened by rising pollution, the oceans are sending out an SOS

The very survival of the human species depends upon the maintenance of an ocean clean and alive, spreading all around the world. The ocean is our planet's life belt.
—Marine Explorer Jacques-Yves Cousteau (1980)

After sweltering through a succession of torrid, hazy and humid days, thousands of New Yorkers sought relief early last month by heading for the area's public beaches. What many found, to their horror and dismay, was an assault on the eyes, the nose and the stomach. From northern New Jersey to Long Island, incoming tides washed up a nauseating array of waste, including plastic tampon applicators and balls of sewage 2 in. thick. Even more alarming was the drug paraphernalia and medical debris that began to litter the beaches: crack vials, needles and syringes, prescription bottles, stained bandages and containers of surgical sutures. There were also dozens of vials of blood, three of which tested positive for hepatitis-B virus and at least six positive for antibodies to the AIDS virus.

To bathers driven from the surf by the floating filth, it was as if something precious—*their* beach, *their* ocean—had been wantonly destroyed, like a mindless graffito defacing a Da Vinci painting. Susan Guglielmo, a New York City housewife who had taken her two toddlers to Robert Moses State Park, was practically in shock. "I was in the water when this stuff was floating around. I'm worried for my children. It's really a disgrace." Said Gabriel Liegey, a veteran lifeguard at the park: "It was scary. In the 19 years I've been a lifeguard, I've never seen stuff like this."

Since the crisis began, more than 50 miles of New York City and Long Island beaches have been declared temporarily off limits to the swimming public because of tidal pollution. Some of the beaches were reopened, but had to be closed again as more sickening debris washed in. And the threat is far from over: last week medical waste was washing up on the beaches of Rhode Island and Massachusetts. "The planet is sending us a message," says Dr. Stephen Joseph, New York City's health commissioner. "We cannot continue to pollute the oceans with impunity."

As federal and state officials tried to locate the source of the beach-defiling materials, an even more mysterious—and perhaps more insidious—process was under way miles off the Northeast coast. Since March 1986, about 10 million tons of wet sludge processed by New York and New Jersey municipal sewage-treatment plants has been moved in huge barges out beyond the continental shelf. There, in an area 106 nautical miles from the entrance to New York harbor, the sewage has been released underwater in great, dark clouds.

Flagged off: no-swimming signals on Long Island

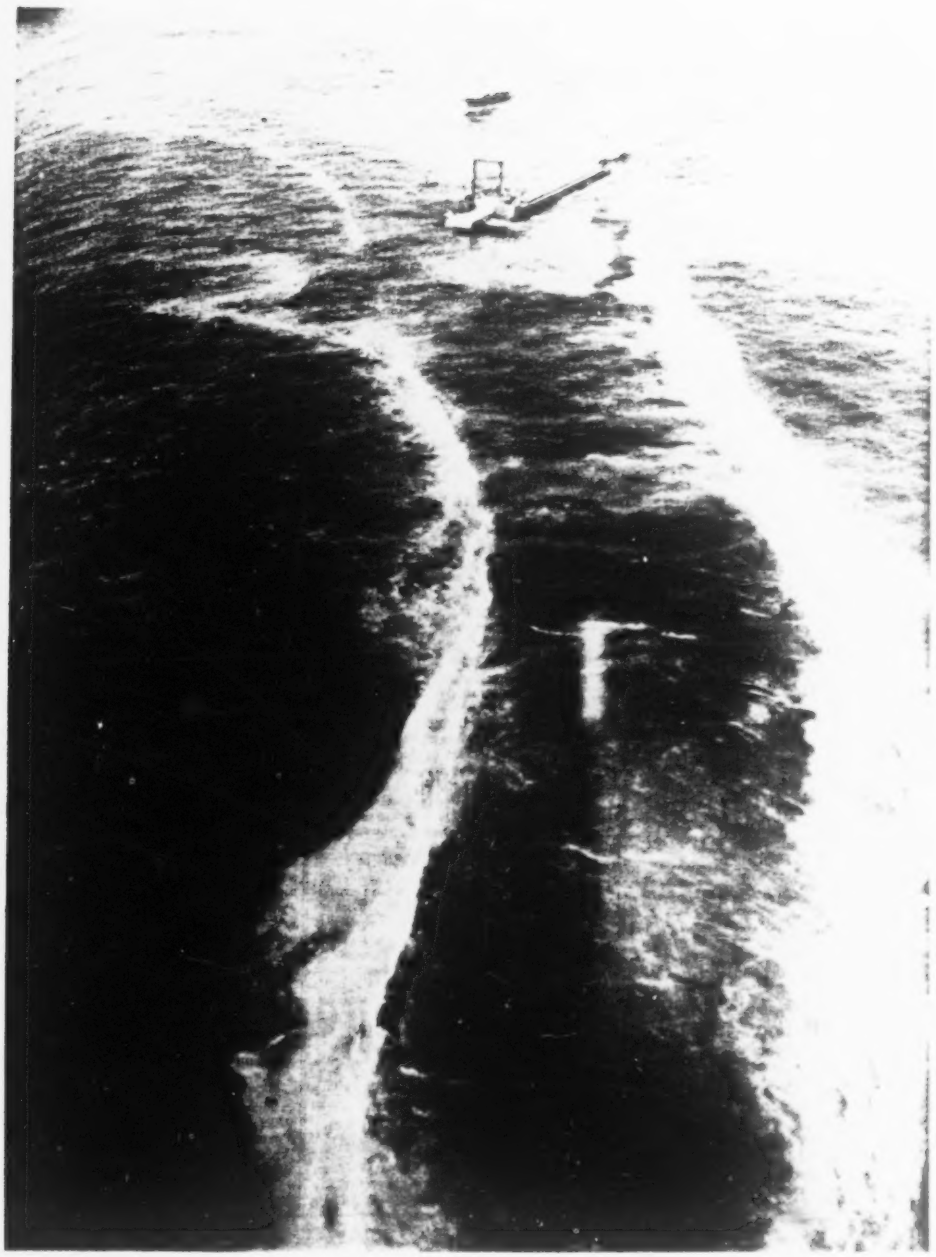
The dumping, approved by the Environmental Protection Agency, has stirred noisy protests from commercial and sport fishermen from South Carolina to Maine. Dave Krusa, a Montauk, N.Y., fisherman, regularly hauls up hake and tilefish with ugly red lesions on their bellies and fins that are rotting away. Krusa is among those who believe that contaminants from Dump Site 106 may be borne back toward shore by unpredictable ocean currents. "In the past year, we've seen a big increase of fish in this kind of shape," he says. Who will eat them? New Yorkers, says a Montauk dockmaster. "They're going to get their garbage right back in the fish they're eating."

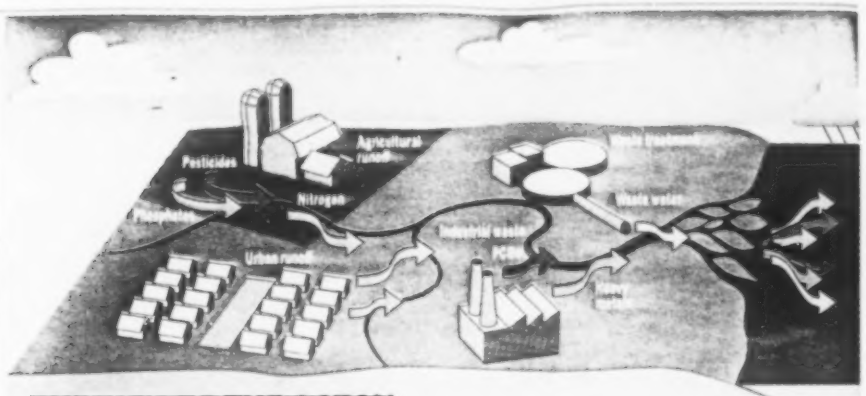
This summer's pollution of Northeastern beaches and coastal waters is only the latest signal that the planet's life belt, as Cousteau calls the ocean, is rapidly unbuckling. True, there are some farsighted projects here and there to repair the damage, and there was ample evidence in Atlanta last week that the Democrats hope to raise the nation's consciousness about environmental problems. The heightened interest comes not a moment too soon, since marine biologists and environmentalists are convinced that oceanic pollution is reaching epidemic proportions.

The blight is global, from the murky red tides that periodically afflict Japan's Inland Sea to the untreated sewage that befouls the fabled Mediterranean. Pollution threatens the rich, teeming life of the ocean and renders the waters off once famed beaches about as safe to bathe in as an unflushed toilet. By far the greatest, or at least the most visible, damage has been done near land, which means that the savaging of the seas vitally affects human and marine life. Polluted waters and littered beaches can take jobs from fisherfolk as well as food from consumers, recreation from vacationers and business from resorts. In dollars, pollution costs billions; the cost in the quality of life is incalculable.

In broadest terms, the problem for the U.S. stems from rampant development along the Atlantic and Pacific coasts and the Gulf of Mexico. Between 1940 and 1980, the number of Americans who live within 50 miles of a seashore increased from 42 million to 89 million—and the total is still mounting. Coastal waters are getting perilously close to reaching their

Crimson carpet: an algae bloom in Osaka Bay last May, one of the hundreds of red tides that appear off Japan each year





THREATS TO THE OCEAN

The major long-term hazard is chronic land- based pollution. Agricultural runoff of fertilizers, topsoil and pesticides is carried by rivers and streams into estuaries. Waste water from factories and sewage-treatment plants includes such toxic substances as heavy metals and PCBs. Overflowing sewers spill raw sewage into the sea, and sludge from some states is deliberately dumped into the Atlantic.

capacity to absorb civilization's wastes.

Today scientists have begun to shift the focus of research away from localized sources of pollution, like oil spills, which they now believe are manageable, short-term problems. Instead, they are concentrating on the less understood dynamics of chronic land-based pollution: the discharge of sewage and industrial waste and—possibly an even greater menace—the runoff from agricultural and urban areas.

Conveyed to the oceans through rivers, drainage ditches and the water table, such pollutants include fertilizers and herbicides washed from farms and lawns, motor oil from highways and parking lots, animal droppings from city streets and other untreated garbage that backs up in sewer systems and spills into the seas. Says Biologist Albert Manville of Defenders of Wildlife, a Washington-based environmental group: "We're running out of time. We cannot continue to use the oceans as a giant garbage dump."

The oceans are broadcasting an increasingly urgent SOS. Since June 1987 at least 750 dolphins have died mysteriously along the Atlantic Coast. In many that washed ashore, the snouts, flippers and tails were pocked with blisters and craters; in others, huge patches of skin had sloughed off. In the Gulf of Maine harbor seals currently have the highest pesticide level of any U.S. mammals, on land or in water. From Portland to Morehead City, N.C., fishermen have been hauling up lobsters and crabs with gaping holes in their shells and fish with rotted fins and ulcerous lesions. Last year's oyster haul in Chesapeake Bay was the worst ever; the crop was decimated by dermo, a fungal disease, and the baffling syndrome MSX (multinucleate sphere X).

Suffocating and sometimes poisonous blooms of algae—the so-called red and brown tides—regularly blot the nation's coastal bays and gulfs, leaving behind a trail of dying fish and contaminated mollusks and crustaceans. Patches of water that have been almost totally depleted of oxygen, known as dead zones, are proliferating. As many as 1 million fluke and flounder were killed earlier this summer when they became trapped in anoxic water in New Jersey's Raritan Bay. Another huge dead zone, 300 miles long and ten miles wide, is adrift in the Gulf of Mexico.

Shellfish beds in Texas have been closed eleven times in the past 18 months because of pollution. Crab fisheries in Lavaca Bay, south of Galveston, were forced to shut down when dredging work stirred up mercury that had settled in the sediment. In neighboring Louisiana 35% of the state's oyster beds are closed because of sewage contamination. Says Oliver Houck, a professor of environmental law at Tulane: "These waters are nothing more than cocktails of highly toxic substances."

The Pacific coastal waters are generally cleaner than most, but they also contain pockets of dead—and deadly—water. Seattle's Elliott Bay is contaminated with a mix of copper, lead, arsenic, zinc, cadmium and polychlorinated biphenyls (PCBs), chemicals once widely used by the electrical-equipment industry. "The bottom of this bay is a chart of industrial history," says Thomas Hubbard, a water-quality planner for Seattle. "If you took a core sample, you could date the Depression, World War II. You could see when PCBs were first used and when they were banned, and when lead was eliminated from gasoline." Commencement Bay, Tacoma's main harbor, is the nation's largest underwater area designated by the Environmental Protection Agency as a Superfund site, meaning that pollution in the bay is so hazardous that the Federal Government will supervise its cleanup.

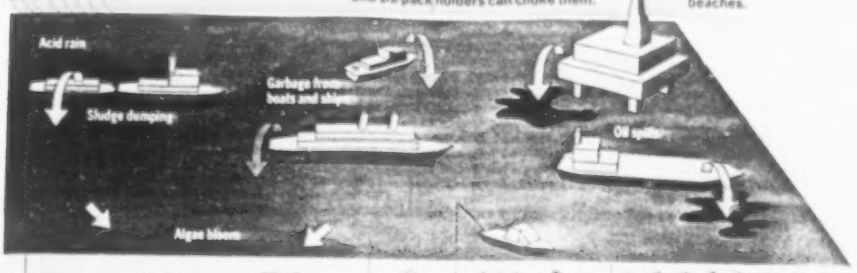
Washington State fisheries report finding tumors in the livers of English sole, which dwell on sediment. Posted signs warn BOTTOMFISH, CRAB AND SHELLFISH MAY BE UNSAFE TO EAT DUE TO POLLUTION. Lest anyone fail to get the message, the caution is printed in seven languages: English, Spanish, Vietnamese, Cambodian, Laotian, Chinese and Korean.

San Francisco Bay is also contaminated with copper, nickel, cadmium, mercu-

Acid rain and wind-borne pesticides fall into estuaries and oceans; they may stimulate algae blooms and destroy spawning grounds.

Recreational boaters, fishermen and ocean-going ships dump their garbage overboard. Much of this waste consists of plastics, which kill millions of birds, mammals and other marine creatures every year. They become entangled in discarded fishing lines and nets, and six-pack holders can choke them.

Oil spills from tankers and offshore drilling rigs are short-term hazards to the ocean and beaches.



Algae feed on nitrogen and phosphorus, leading to explosive growths (red and brown tides). These growths, or blooms, block the sunlight to submerged plants and kill them. When the algae decay, they rob the ocean of oxygen, suffocating sea creatures and producing massive fish kills. Toxins from algae can also kill fish.

When heavy metals, PCBs and toxic algae are ingested by marine life, it becomes contaminated and inedible.

One pollutant by itself may not be lethal, but the combined effect of many pollutants can create stress in marine life, resulting in burn holes in lobsters, fin rot and ulcers on fish.

rs and other heavy metals from industrial discharges. Last year toxic discharges increased 23%. In Los Angeles urban run-off and sewage deposits have had a devastating impact on coastal ecosystems, notably in Santa Monica Bay, which gets occasional floods of partly processed wastes from a nearby sewage-treatment plant during heavy rainstorms. Off San Diego's Point Loma, a popular haunt of skin divers, the waters are so contaminated with sewage that undersea explorers run the risk of bacterial infection.

U.S. shores are also being inundated by waves of plastic debris. On the sands of the Texas Gulf Coast one day last September, volunteers collected 807 tons of litter, two-thirds of which was plastic, including 31,751 bags, 30,295 bottles and 15,631 six-pack yokes. Plastic trash is being found far out to sea. On a four-day trip from Maryland to Florida that ranged 100 miles offshore, John Hardy, an Oregon State University marine biologist, spotted Styrofoam and other plastic on the surface most of the whole cruise.

Nonbiodegradable plastic, merely a nuisance to sailors, can kill or maim marine life. As many as 2 million seabirds and 100,000 marine mammals die every year after eating or becoming entangled in the debris. Sea turtles choke on plastic bags they mistake for jellyfish, and sea lions are ensnared when they playfully poke their noses into plastic nets and rings. Unable to open their jaws, some sea lions simply starve to death. Brown pelicans become so enmeshed in fishing line that they can hang themselves. Says Kathy O'Hara of the Center for Environmental Education in Washington: "We have seen them dangling from tree branches in Florida."

Some foreign shores are no better off. Remote beaches on Mexico's Yucatán Peninsula are littered with plastics and

Grim caution: a sign on Puget Sound

lines. Fish and birds are being choked off Guanabara Bay, the entryway to Rio de Janeiro, by sewage and industrial fallout. Japan's Inland Sea is plagued by 200 red tides annually; one last year killed more than 1 million yellowtail with a potential market value of $15 million. In the North Sea chemical pollutants are believed to have been a factor in the deaths of 1,500 harbor seals this year. Last spring the Scandinavian fish industry was hard hit when millions of salmon and sea trout were suffocated by an algae bloom that clung to their gills and formed a slimy film. Farmers towed their floating fish pens from fjord to fjord in a desperate effort to evade the deadly tide.

For five years at 200 locations around the U.S. the National Oceanic and Atmospheric Administration has been studying mussels, oysters and bottom-dwelling fish like flounder that feed on the pollutant-rich sediment. These creatures, like canaries placed in a coal mine to detect toxic gases, serve as reliable indicators of the presence of some 50 contaminants. The news is not good. Coastal areas with dense populations and a long history of industrial discharge show the highest levels of pollution. Among the worst, according to Charles Ebert of NOAA, Boston Harbor, the Hudson-Raritan estuary on the New Jersey coast, San Diego harbor and Washington's Puget Sound.

Environment

Last week the EPA added six major estuaries to the half a dozen already on the list of ecologically sensitive coastal areas targeted for long-term study. Estuaries, where rivers meet the sea, are the spawning grounds and nurseries for at least two-thirds of the nation's commercial fisheries, as well as what the EPA calls sources of "irreplaceable recreation and aesthetic enjoyment."

Although the poisoning of coastal waters strongly affects vacationers, homeowners and resort operators, its first (and often most vocal) victims are fishermen. Commercial fishing in the U.S. is a $3.1 billion industry, and it is increasingly threatened. Fisherman Richard Hambley of Swansboro, N.C., recalls that only a few years ago, tons of sturgeon and mullet were pulled out of the White Oak River. "Now that is nonexistent," he says. "There are no trout schools anymore. Crabs used to be like fleas. I'm lucky to get a few bushels." Ken Seigler, who works Swansboro's Queens Creek, has seen his income from clams and oysters drop 50% in seven years; this year he was forced to apply for food stamps. New Jersey Fisherman Ed Maliszewski has used his small boat for only two weeks this year. He is trying to bail out, and so are others.

In the diet-and-wellness '80s, fish has been widely touted as a healthful food. Not only do smaller catches mean ever higher prices, but also the incidence of illnesses from eating contaminated fish—including gastroenteritis, hepatitis A and cholera—is rising around the U.S. Pesticide residues and other chemicals so taint New York marine waters that state officials have warned women of childbearing age and children under 15 against consuming more than half a pound of bluefish a week; they should never eat striped bass caught off Long Island. Says Mike Deland, New England regional administrator for the EPA: "Anyone who eats the liver from a lobster taken from an urban area is living dangerously."

Fish and shellfish that have absorbed toxins can indirectly pass contaminants to humans. Birds migrating between Central America and the Arctic Circle, for example, make a stopover in San Francisco's wetlands, where they feast on clams and mussels that contain high concentrations of cadmium, mercury and lead. Says Biologist Gregory Karras of Citizens for a Better Environment: "The birds become so polluted, there is a risk from eating ducks shot in the South Bay."

Despite the overwhelming evidence of coastal pollution, cleaning up the damage, except in a few scattered communities, has a fairly low political priority. One reason: most people assume that the vast oceans, which cover more than 70% of the world's surface, have an inexhaustible capacity to neutralize contaminants, by either absorbing them or letting them settle harmlessly to the sediment miles below the surface. "People think 'Out of sight, out of mind,'" says Richard Curry, an oceanographer at Florida's Biscayne National Park. The popular assumption that oceans will in effect heal themselves may carry some truth, but scientists warn that this is simply not known. Says Marine Scientist Herbert Windom of Georgia's Skidaway Institute of Oceanography: "We see things that we don't really understand. And we don't really have the ability yet to identify natural and unnatural phenomena." Notes Sharron Stewart of the Texas Environmental Coalition: "We know more about space than the deep ocean."

Marine scientists are only now beginning to understand the process by which coastal waters are affected by pollution. The problem, they say, may begin hundreds of miles from the ocean, where nutrients, such as nitrogen and phosphorus, as well as contaminants, enter rivers from a variety of sources. Eventually, these pollutants find their way into tidal waters. For the oceans, the first critical line of defense is that point in estuaries, wetlands and marshes where freshwater meets salt water. Marine biologists call this the zone of maximum turbidity—literally, where the water becomes cloudy from mixing.

There, nutrients and contaminants that have dissolved in freshwater encounter the ionized salts of seawater. The resulting chemical reactions create particles that incorporate the pollutants, which then settle to the bottom. As natural sinks for contaminants, these turbidity zones protect the heart of the estuary and the ocean waters beyond.

But the fragile estuarine systems can be overtaxed in any number of ways. Dredging can stir up the bottom, throwing pollutants back into circulation. The U.S. Navy plans to build a port in Puget Sound for the aircraft carrier U.S.S. *Nimitz* and twelve other ships; the project will require displacement of more than 1 million cu yds. of sediment, with unknown ecological consequences. Similarly, natural events such as hurricanes can bestir pollutants from the sediment. The estuarine environment also changes when the balance of freshwater and salt water is disturbed. Upstream dams, for example, diminish the flow of freshwater into estuaries; so do droughts. On the other hand, rainstorms can cause an excess of freshwater runoff from the land.

Whatever the precise cause, trouble begins when the level of pollutants in the water overwhelms the capacity of estuaries to assimilate them. The overtaxed system, unable to absorb any more nutrients or contaminants, simply passes them along toward bays and open coastal areas. "When the system is working," says Maurice Lynch, a biological oceanographer at

Pacific plunge: mounds of colorful plastic debris litter the sands of Nihau, an island in the Hawaiian chain

the Virginia Institute of Marine Science, "it can take a lot of assault. But when it gets out of whack, it declines rapidly."

It is then that the natural growth of sea grass may be ended, as has happened in Chesapeake Bay, or sudden blooms of algae can occur, particularly in stagnant waters. The exact reasons for these spurts of algal growth are unknown. They can be triggered, for example, by extended periods of sunny weather following heavy rains. Scientists believe algal growth is speeded up by the runoff of agricultural fertilizers. The burgeoning algae form a dense layer of vegetation that displaces other plants. As the algae die and decay, they sap enormous amounts of oxygen from the water, asphyxiating fish and other organisms.

Some kinds of algae contain toxic chemicals that are deadly to marine life. When carcasses of more than a dozen whales washed up on Cape Cod last fall, their deaths were attributed to paralytic shellfish poisoning that probably passed up the food chain through tainted mackerel consumed by the whales. Carpets of algae can turn square miles of water red, brown or yellow. Some scientists speculate that the account in *Exodus* 7: 20 of the Nile's indefinitely turning red may refer to a red tide.

When such blights occur in coastal areas, the result can be devastating. Last November a red tide off the coast of the Carolinas killed several thousand mullet and all but wiped out the scallop population. Reason: the responsible species, *Ptychodiscus brevis*, contains a poison that causes fish to bleed to death. Brown tides, unknown to Long Island waters before 1985, have occurred every summer since; they pose a constant threat to valuable shellfish beds.

A study of satellite photographs has led scientists to believe that algae can be conveyed around the world on ocean currents. The Carolinas algae, which had previously been confined to the Gulf of Mexico, apparently drifted to Atlantic shores by way of the Gulf Stream. One species that is native to Southern California is thought to have been carried to Spain in the ballast water of freighters.

The effects of man-made pollution on coastal zones can often be easily seen; far less clear is the ultimate impact on open seas. The ocean has essentially two ways of coping with pollutants: it can dilute them or metabolize them. Pollutants can be dispersed over hundreds of square miles of ocean by tides, currents, wave action, huge underwater columns of swirling water called rings, or deep ocean storms caused by earthquakes and volcanoes.

Buried toxins can also be moved around by shrimp and other creatures that dig into the bottom and spread the substances through digestion and excretion. Though ocean sediment generally accumulates at a rate of about one-half inch per thousand years, Biogeochemist John Farrington of the University of Massachusetts at Boston cites discoveries of plutonium from thermonuclear test blasts in the 1950s and 1960s located 12 in. to 20 in. deep in ocean sediment. Thus contaminants can conceivably lie undisturbed in the oceans indefinitely—or resurface at any time.

Atlantic agony: a dead dolphin, brought in by the tide, lies rotting near an amusement park on southern New Jersey's beleaguered shore

There is little question that the oceans have an enormous ability to absorb pollutants and even regenerate once damaged waters. For example, some experts feared that the vast 1979 oil spill in the Gulf of Mexico would wipe out the area's shrimp industry. That disaster did not occur, apparently because the ocean has a greater capacity to break down hydrocarbons than scientists thought. But there may be a limit to how much damage a sector of ocean can take. Under assault by heavy concentrations of sludge, for example, the self-cleansing system can be overwhelmed. Just like decaying algae, decomposing sludge robs the water of oxygen, suffocating many forms of marine life. What effect chronic contamination from sludge and other wastes will have on the oceans' restorative powers is still unknown.

Rebuckling the planet's life belt may prove formidable. The federal Clean Water Act of 1972 overlooked runoff pollution in setting standards for water quality. Meanwhile, the nation's coasts are subject to the jurisdiction of a bewildering (and often conflicting) array of governmental bodies. One prime example of this confusion, reports TIME Houston Bureau Chief Richard Woodbury, is found in North Carolina's Albemarle-Pamlico region. There both the federal Food and Drug Administration and a state agency regulate the harvesting of shellfish. A third agency, the state's health department, surveys and samples the water and shellfish. And another state body sets the guidelines for opening or closing shellfish beds. Complains Douglas Rader of the Environmental Defense Fund: "The crazy mix of agencies hurts the prospects for good management."

Lax enforcement of existing clean-water policies is another obstacle. According to Clean Ocean Action, a New Jersey–based watchdog group, 90% of the 1,500 pipelines in the state that are allowed to discharge effluent into the sea do so in violation of regulatory codes. Municipalities flout the rules as well. Even if Massachusetts keeps to a very tight schedule on its plans to upgrade sewage treatment, Boston will not be brought into compliance with the Clean Water Act until 1999—22 years after the law's deadline. Meanwhile, the half a billion gallons of sewage that pour into Boston Harbor every day receive treatment that is rudimentary at best.

Some communities are leading the way in trying to preserve their shores and coastal waters. In March the legislature of Suffolk County on Long Island passed a law

forbidding retail food establishments to use plastic grocery bags, food containers and wrappers beginning next year. Sixteen states have laws requiring that the plastic yokes used to hold six-packs of soda or beer together be photo- or biodegradable. Last December the U.S. became the 29th nation to ratify an amendment to the Marpol (for marine pollution) treaty, which prohibits ships and boats from disposing of plastics—from fishing nets to garbage bags—anywhere in the oceans. The pact goes into effect at the end of this year.

Compliance will not be easy. Merchant fleets dump at least 450,000 plastic containers overboard every day. The U.S. Navy, which accounts for four tons of plastic daily, has canceled a contract for 11 million plastic shopping bags, and is testing a shipboard trash compactor. It is also developing a waste processor that can melt plastics and turn them into bricks. The Navy's projected cost of meeting the treaty provision: at least $1 million a ship. Supporters of the Marpol treaty readily acknowledge that it will not totally eliminate plastic pollution. "If a guy goes out on deck late at night and throws a bag of trash overboard," says James Coe of NOAA's National Marine Fisheries Service in Seattle, "there's no way that anyone will catch him."

Stiff fines and even prison sentences may get the attention of landbound polluters. Under Administrator Mike Deland, the EPA's New England office has acquired a reputation for tough pursuit of violators. In November 1986 the agency filed criminal charges against a Providence boatbuilder for dumping PCBs into Narragansett Bay. The company was fined $600,000 and its owner $75,000; he was put on probation for five years.

Washington is one of the few states with a comprehensive cleanup program. Three years ago, the Puget Sound water-quality authority developed a master plan for cleaning up the heavily polluted, 3,200-sq.-mi. body of water. The state legislature has levied an 8¢-a-pack surtax on cigarettes to help pay the bill; this year the tax will contribute an estimated $25 million to the cleanup. The Puget Sound authority and other state agencies closely monitor discharge of industrial waste and are working with companies on ways to reduce effluent.

An aggressive effort is being made to limit runoff as well. Two counties have passed ordinances that regulate the clearing of land and the installation and inspection of septic tanks. Farmers are now required to fence cattle away from streams. Zoning has become more stringent for construction in a critical watershed area: a single-family house requires at least two acres of land. The number of livestock and poultry per acre is also controlled.

The Puget Sound group has an educational program that teaches area residents everything from the history of the sound to what not to put down the kitchen sink. Controlling pollution is promoted as everyone's task. High school students take water samples, and island dwellers have been trained in what to do if they spot an oil spill. Says Seattle Water-Quality Planner Hubbard: "Bridgetenders are great at calling in with violations. They are up high, and when they see a black scum or a little slick, they let us know about it."

Officials hope the cleanup program will have the same result as a decades-long effort mounted by the Federal Government and four states in the Delaware River estuary, an area ringed by heavy industry and home to almost 6 million people. The Delaware's pollution problems began in Benjamin Franklin's day. By World War II, the river had become so foul that airplane pilots could smell it at 5,000 ft. President Franklin Roosevelt even considered it a threat to national security. In 1941 he ordered an investigation to determine whether gases from the water were causing corrosion at a secret radar installation on the estuary.

Although the Delaware will never regain its precolonial purity, the estuary has been vastly improved. Shad, which disappeared 60 years ago, are back, along with 33 other species of fish that had virtually vanished. Estuary Expert Richard Albert calls the Delaware "one of the premier pollution-control success stories in the U.S."

Such triumphs are still rare, and there is all too little in the way of concerted multinational activity to heal the oceans. That means pollution is bound to get worse. Warns Clifton Curtis, president of the Oceanic Society, a Washington-based environmental organization: "We can expect to see an increase in the chronic contamination of coastal waters, an increase in health advisories and an increase in the closing of shellfish beds and fisheries." Those are grim tidings indeed, for both the world's oceans and the people who live by them. —*By Anastasia Toufexis.*

Reported by Andrea Dorfman/New York, Eugene Linden/Boston and Edwin M. Reingold/Seattle

TESTIMONY OF:

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Before the Hearing on the
Massachusetts Bay Protection Act of 1988
Subcommittee on Oceanography
Merchant Marine and Fisheries Committee
United States House of Representatives

Thank you for the opportunity to present testimony on the legislation, "To amend the Federal Water Pollution Control Act to include Massachusetts Bay, Massachusetts, in the National Estuary Program ", H. R. 4883, 100th Congress, 2D Session. Discussions with colleagues at the University of Massachusetts at Boston and at many of the regional institutions having marine expertise have been of benefit in the preparation of this testimony. My statement is that of an individual scientist and educator and not an official position statement of the University of Massachusetts at Boston.

I am an associate professor in the Environmental Sciences Program at the University of Massachusetts at Boston. My doctoral training was at the Graduate School of Oceanography at the University of Rhode Island where I was awarded a PhD in Chemical Oceanography in 1976. My research interests have, and continue to be, in the areas of the geochemistry and biogeochemistry of metals in marine waters. After postdoctoral training at the Skidaway Institute of Oceanography, part of the University of Georgia System, I was appointed there as an assistant professor. In the fall of 1982 I joined the then fledgling Environmental Sciences Program at the University of Massachusetts at Boston. From the outset my colleagues and I in the Environmental Sciences Program, which has a strong commitment to doctoral training and research in primarily marine coastal sciences and an emphasis on integration of science and technology with marine policy and management, joined colleagues at other academic institutions in the area to provide expertise to the state in the area of coastal marine water quality concerns. Most of our efforts have focused on problems raised by the continued discharge of large quantities of sewage effluent and sludge to the waters of Boston Harbor and Massachusetts Bay. In this capacity I have served as a member of the Massachusetts Executive Office of Environmental Affair's Advisory Board for Boston's 310h Waiver Application and subsequently as a member of the same office's Technical Advisory Group for Boston Harbor and Massachusetts Bay. My own research efforts have most recently focused on the distribution and transport of potentially toxic metals in Boston Harbor, Salem Harbor and Massachusetts Bay and the accumulation of these metals in commercially important seafood organisms taken from these waters. It is from this perspective and background that I offer this testimony.

The coastal waters of Massachusetts enclosed by a line drawn between Provincetown on the tip of Cape Cod to Cape Ann, just north of Gloucester, Massachusetts, form the geographic boundary of the embayment containing Massachusetts Bay to the north and Cape Cod Bay to the south. The value of marine related resources of eastern Massachusetts waters has been recognized in one fashion or another, first as offering refuge and abundance of food to the native indians and colonial settlers and currently as both a valuable multifaceted commercial resource and source of numerous recreational opportunities. However this embayment, and particularly Boston Harbor, have been used, and will continue to be used, as a receptor of substantial quantities of a wide variety of both domestic and industrial wastes, a use in clear conflict with those anticipated by other users such as the commercial fisherman, waterfront developer and recreating public. These conflicting uses raise the question of how best can we accommodate the needs of the various user groups in addition to meeting Clean Water Act standards and other regulatory criteria? I submit that current attempts to address this question

suffer from a severe lack of understanding of the very nature of the resource that we are seeking to both protect and use. Only by development of an increased comprehensive understanding of the functioning and resources of this embayment, such as that mandated by this legislation, will more cost-effective and scientifically valid solutions to this complex question be achieved.

An assessment of the current status of this embayment is in order here. Boston Harbor has achieved national recognition as one of the most heavily contaminated estuaries in the country, principally as a result of the discharge of raw and/or poorly treated industrial and domestic sewage and sewage sludge directly to the harbor over the last century. The result of this activity are harbor sediments containing potentially toxic metals such as copper, lead, zinc, mercury, cadmium and others in concentrations that are among the highest reported anywhere (White,1972; Fitzgerald, 1980; Wallace, 1987). Similarly sediment concentrations of carcinogenic petroleum aromatic hydrocarbons (PAHs) in Boston Harbor are also among the highest reported in the marine environment (Boehm et al., 1984; Shiaris and Jambard-Sweet, 1986). Metal concentrations in the water column are ten to a hundred times those expected in clean coastal seawater (Wallace et al., 1988). Dissolved oxygen concentrations in some areas of the Harbor frequently are below state and federal standards. Shell-fish beds and prime beach areas in the harbor are either closed or restricted because of widespread fecal coliform contamination. Some of these findings and others pertinent to understanding the status of the Harbor were presented as part of the NOAA Estuary-of-the-Month Seminar Series here in Washington in June of 1985 (Brown, 1987).

Recent work has demonstrated the biological consequences of this contamination. In 1985, Murchelano and Wolke reported in the journal, Science, that the incidence of observation of vacuolar cell lesions in the livers of winter flounder from Boston Harbor was 68% and, as such, much higher than those observed in winter flounder from other northeast estuaries. Stockmeyer (1988) found that soft-shelled clams (Mya arenaria) taken from Boston Harbor have a higher incidence of overall pathology indicative of environmental stress when compared to controls sampled in Nantucket Island. Benthic populations in the harbor have been altered with respect to species diversity and abundances. In some areas even the pollutant tolerant species cannot be found (Gallagher and Grassle, 1988).

A recent study conducted in Quincy Bay (Metcalf & Eddy, Inc./U.S. EPA Environmental Research Laboratory, Narragansett, 1988), a small embayment within Boston Harbor which receives sewage effluent from one of the two sewage plants discharging directly to the Harbor, also revealed that flounder and soft-shelled clams "were found to exhibit an extremely high incidence of several conditions believed by the investigators to be associated with environmental stress and poor health". The investigators also concluded "the incidence of several of these conditions to be unusually high in comparison to results obtained at other New England study locations". Clearly the quality and quantity of contaminants introduced into the harbor have resulted in substantial degradation of the ecosystem and significant economic losses in the form of closed or restricted fisheries.

Available but highly uncertain estimates suggest that most of the contaminants released from the sewage plants are not retained in the harbor but transported to the adjacent waters of Massachusetts and Cape Cod Bays. Fitzgerald (1980) estimates that about 3% of the metals released from the sewage plants are retained in the Harbor sediments, the remaining portion being transported to the sediments of the Bays or possibly transported to the Gulf of Maine. Sediments in Massachusetts and Cape Cod Bay contain elevated concentrations of both metal and organic contaminants. Boehm (1987) estimates that the PCB and PAH concentrations in Massachusetts Bay and Cape Cod Bay sediments are quite similar to those of the New York Bight Apex. In my laboratory we have found concentrations of some metals in the water column of Massachusetts Bay to be two to three times those found in southern New England coastal waters (Wallace and Gardner, in preparation). Nutrient concentrations in Bay waters adjacent to Boston Harbor are elevated and depressed oxygen concentrations have been observed in the deeper waters of Massachusetts Bay. While there is little evidence to suggest the Massachusetts and Cape Cod Bays show signs of ecosystem stress other than in the chemical signals, it is quite obvious that somewhere along the as yet poorly defined chemical gradients between the heavily contaminated sediments and water column of the Harbor and the less severely contaminated sediments and water column of the Bays, there is a transition between the obviously stressed ecosystem of the Harbor and the apparently little effected ecosystem of the Bays. The nature of this transition in both pollutant and ecosystem health gradients is not known.

Exchange of water in these Bays with Gulf of Maine water to the east is restricted because of the presence of Stellwagen Bank extending from the tip of Cape Cod to within 20 km of Cape Anne to the north. Maximum depths on the order of 100 m are found in the vicinity of Stellwagen Basin although the greater part of Massachusetts and Cape Cod Bays is shallower than 40 m. From scientific and management perspectives, the embayment should be considered as a semi-enclosed, single system wherein perturbations in any part are likely to affect all other parts to some degree. Thus waste disposal practices adopted in Boston, for example, can be expected to affect water quality conditions in Massachusetts and probably to a lesser extent Cape Cod Bays.

The most important fresh water sources to the Bays are the Charles River in Boston and the Merrimack River. The latter river discharges north of Cape Ann but the bulk of its fresh water is transported southward along the coast and enters Massachusetts and Cape Cod Bays. Additional sources of fresh water to the Bays are in the form of sewage discharges from Boston and other coastal communities, the magnitude of which often exceed the flow of the Charles River. Fresh water entering the Bays from all sources, particularly the Merrimack, influence the circulation patterns in the Bays (Butman, 1975; Gardner et al., 1986). Residual circulation patterns, the residence time of water in the Bays, and the sensitivity of these parameters to seasonal changes in fresh water input and other climatological factors are largely unknown.

There is a common belief that the primary sources of contaminants to Massachusetts and Cape Cod Bays are the publicly-owned waste treatment plants discharging either directly or indirectly to the Bays. However evidence obtained in our laboratory and those of others suggest other sources may be of major importance. We have made some admittedly very uncertain estimates

(because of the lack of appropriate data) that both the Merrimack River (formerly labeled as one of the ten most polluted rivers in the country) and atmospheric deposition (because of the large quantities of contaminants injected into the atmosphere in the mid-western and northeastern U.S.) may be important sources of metals and other contaminants to the Bays. Still another important source has been identified by Windsor and Hites (1979) who present evidence that the resuspension and transport of PAH contaminated sediments from Boston Harbor are an important source of these carcinogenic compounds to Massachusetts Bay and the sediments of the deep basins of the Gulf of Maine. The bulk of the PAHs are believed to be combustion-generated, enter the Harbor/Bay system via runoff, and are then transported offshore. In my opinion we do not yet fully understand either the nature of the sources nor the processes controlling the subsequent transport of contaminants in this system.

Part of the reason for our ignorance in this regard is the lack of fundamental knowledge of the physics, chemistry, and biology of the Bay ecosystem. The physical circulation of the water in Massachusetts and Cape Cod Bays is not well understood nor are the principal forces driving that circulation. Fundamental pieces of information such as the residence time of water in the Bay system and residual circulation patterns remain unknown. This information is of critical importance in determining the probable fate of contaminants entering this system. For example we know that many of the contaminants of concern are "particle-reactive"; that is they have a high affinity for the surface of particles. Once adsorbed to the surface of particles their transport and fate in the aquatic environment is dictated by processes affecting the fate of the particles they are attached to. These contaminant-laden particles may then be incorporated into the sediments or transported further offshore. Knowledge of the time scale of these processes, when compared to that of the residence time of the water in the Bays, can lead to important projections on the probable fate of contaminants introduced into the system.

We also now know that biological and chemical processes occurring both in the water column and in the sediment also profoundly influence the transport, fate and toxicity of contaminants in aquatic ecosystems. These processes, in conjunction with the physical processes mentioned earlier dictate the ultimate fate and consequences of contaminants in our coastal waters. Carefully designed and planned measurements can provide quantitative information on the nature of these processes which can then be integrated with appropriate physical circulation models to provide initial estimates of the probable fate of contaminants. By appropriate sensitivity analysis and ground truthing of such models, their use may well help answer critical management problems concerned with waste disposal as well as other uses of the ecosystem.

Unfortunately the data base for Massachusetts Bay and Cape Cod Bays is exceedingly poor. In the process of obtaining information for a course I teach on urban estuaries, I searched the available data bases for references on a number of major anthropogenically impacted estuaries as well as for Boston Harbor, and Massachusetts and Cape Cod Bays in both the refereed and non-refereed literature. The result of that search indicated a total of 1010 listings for Chesapeake Bay, 374 for Puget Sound, 328 for San Francisco Bay,

288 for Narragansett Bay, and 61 for Boston Harbor/Massachusetts Bay/Cape Cod Bay. Of the 61 references found only 45 remotely offer information of use in the development of management strategies for the Harbor/Bay system. Only a few are of the type that contribute to the basic knowledge of the system which must serve as the necessary foundation for support of wise management of the Harbor/Bay System.

Because of the often costly nature of management options applied to coastal waters (on the order of billions of dollars for Boston and hundreds of millions for other coastal communities in eastern Massachusetts for sewage abatement alone), the uncertainties surrounding choices of such options take on added significance. The complexity of the problems and their solutions require close cooperation and interaction between scientists and managers to successfully integrate and promote the wise and cost effective management of the valuable resources of our coastal ecosystems. My concerns are that such efforts have not been nearly as successful as they might be and must be improved. I refer you to the attached article "The Reclamation of Boston Harbor: A Scientists Perspective", an invited paper prepared for the New England Journal of Policy, in which my thoughts in this regard are more fully developed.

In summary, the waters of Massachusetts Bay, Cape Cod Bay and Boston Harbor, because of their proximity to the industrial heartland of the U.S. and growing coastal population, will probably continue to receive large quantities of contaminants via atmospheric, riverine and sewage discharges. Boston's relocated secondary sewage outfall in Massachusetts Bay will be one of the single largest such discharges in the country. The relatively shallow depths, restricted circulation, probable magnitude of the point and non-point sources of contaminants and existing evidence of environmental degradation raise considerable concern for the future of this embayment. Knowledge of the physical, chemical and biological processes controlling the fate, transport and effects of contaminants entering this ecosystem is grossly inadequate. Uncertainties with respect to the quantity and quality of the sources of these contaminants are unacceptably large. Our ignorance in these areas will continue to inhibit efficient development of appropriate management strategies for the restoration and preservation of the environmental quality of Massachusetts and Cape Cod Bays for the benefit and enjoyment of future generations.

Thank you again for the opportunity to testify in support of this bill and I welcome any questions you might have.

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New England Journal of Public Policy

Summer/Fall 1986
Volume 2, No. 2

Editor's Note — 3
Padraig O'Malley

Poverty Amid Renewed Affluence: The Poor of New England at Mid-Decade — 6
Andrew M. Sum
Paul E. Harrington
William B. Goedicke
Robert Vinson

Managing Change: Reflections on Innovation in the Public Sector — 31
Ira A. Jackson
Jane P. O'Hern

The Reclamation of Boston Harbor: A Scientist's Perspective — 51
Gordon T. Wallace, Jr.

The Clouds: A Portrait of One Family in Wartime Cambridge — 64
Fanny Howe

Demographic Trends in Boston: Some Implications for Municipal Services — 75
Margaret C. O'Brien

The Next Threshold: Higher Skills and the New England Economy — 91
John C. Hoy

Imagining Boston: The City as Image and Experience — 122
Shaun O'Connell

The Reclamation of Boston Harbor: A Scientist's Perspective

Gordon T. Wallace, Jr.

A major effort, costing in the neighborhood of $2 billion, is under way to restore the environmental quality of Boston Harbor. While Boston Harbor is unquestionably one of the most polluted urban estuaries in the world, it is also one of the least understood with respect to the basic physics, chemistry, and biology involved. This information is essential for the purpose of identifying processes that control the transport, effect, and fate of contaminants entering the estuary. Failure to obtain this information may lead to continued inappropriate and unnecessarily expensive solutions to a complex environmental problem. An effective solution will require commitment to a substantial multidisciplinary research effort to supply the necessary comprehensive data base on the harbor and adjacent environments of Massachusetts and Cape Cod bays. Only then can intelligent, informed decisions be made to assure restoration and maintenance of the environmental quality of our coastal waters. Development of a well-informed and vocal citizens' action group may be a critical step in the achievement of this goal.

Boston Harbor is one of the most beautiful urban estuaries in the continental United States. Carved out by glaciers some ten thousand years ago, it still retains the basic characteristics that we find most desirable in our coastal waters: safe refuge for both large and small vessels; sheltered coves; beautiful and surprisingly remote islands; a variety of shorelines, ranging from sandy beaches to rugged, rocky foreshore; and abundant fish and shellfish that support both commercial and recreational fisheries.

A History of Abuse

Boston Harbor is also among the most battered and abused water bodies in the world. Levels of contaminants in its sediments and in its water equal or exceed

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those of the most polluted estuaries of the world. The history of abuse leading to this condition extends back well into the past century and beyond. The presence of Boston – New England's premier "city by the sea" – has exacted a severe toll on this great resource. A portion of this destruction it will never recover from – such as the loss of over 50 percent of the wetlands in the inner part of the harbor to accommodate large sections of Boston's expansion and growth.

More recent insults are the growing input of contaminants in the harbor, which has paralleled the growth of Boston and her neighboring communities, and an incredible lack of environmental awareness and concern on the part of the local citizenry. The combination of these factors has produced what is generally recognized as an international disgrace, especially for one of the most advanced nations in the world. Only now, as the result of pressure from active conservation groups, such as the Conservation Law Foundation, and from the courts, former judge Paul Garrity, and a dynamic EPA Region I administrator, Michael Deland, are steps being taken to begin the reclamation of Boston Harbor. It will be a long, painful, and very expensive process, and it is taking place in an almost total absence of scientific understanding of the harbor and its adjacent waters, Massachusetts and Cape Cod bays.

The Price of Ignorance

In the text that follows I hope to establish an awareness that the absence of scientific knowledge regarding the issue at hand raises significant questions concerning the reclamation and future of the harbor and the future of Massachusetts and Cape Cod bays. I write this article from the perspective of a scientist working in the area of marine science and, more specifically, as one who is actively conducting research concerning the transport, fate, and biological effects of metals in marine waters. This area of research represents but a small fraction of current efforts to determine the sensitivity of oceanic and coastal environments to anthropogenic (man-made) influence. The need for information from such studies is becoming even greater as man's ability to affect environmental conditions grows.

Most researchers working in the environmental sciences quickly learn that they must be aware of and consider many different processes when attempting to solve environmental problems. The solution to most such problems must address important variables in the fields of biology, physics, and chemistry which influence the phenomenon under scrutiny. Failure to do so may lead to improper interpretation of results and therefore to erroneous conclusions. In short, most environmental questions are inherently complex, requiring a multidisciplinary approach for their solution.

The Scientist and the Manager

And therein lies another problem. In general, scientists are conservative in their judgment as to when a given problem has been "solved." Invariably, in the conduct of scientific research, the solution to one question raises additional questions. Given his inquisitive nature, the practicing scientist finds this aspect of his work extremely rewarding, but to those who wish to apply the solution to existing problems, it is immensely frustrating. The manager who needs to translate

research results into action in order to solve a given environmental problem is often working under a time constraint. He or she is frequently viewed as more than willing to sacrifice thoroughness of knowledge for the sake of meeting deadlines. The scientist, on the other hand, is often perceived as wishing to prolong support of his or her own research interests beyond what is required to "satisfactorily" answer the question posed and, as a result, is thought not to be genuinely concerned about the needs of the manager.

There is some truth in both these views. The trouble is that this mutual distrust results in a reluctance on the part of both the manager and the academic scientist to work with the other, and it is only through their cooperation that state-of-the-art techniques can be brought to bear upon important environmental problems. The lack of a working partnership leads to less than satisfactory resolution of environmental problems and, ultimately, to the application of remedial action which, in many cases, is extremely expensive to implement. Recent and current activities aimed at improving the environmental quality of Boston Harbor serve to demonstrate these unhappy consequences.

Boston Harbor/Massachusetts Bay;
A Worst Case Scenario

I know of no other major estuary adjacent to a large U.S. population center of which so little is understood in terms of the system's basic physics, chemistry, and biology. Perhaps there are two principal reasons for this lack of understanding. The first is a general tendency for marine scientists to focus on globally important phenomena rather than on coastal marine problems. Certainly this is reflected in the objectives of the major funding agencies that supply most of the monies for research in the marine environment. Second, those estuaries and adjacent coastal waters that do enjoy a more comprehensive data base are in proximity to academic institutions with active marine research programs. For example, Narragansett Bay benefits from the presence of the University of Rhode Island's Graduate School of Oceanography; Buzzards Bay, from the Woods Hole Oceanographic Institution; Long Island Sound, from the marine programs at the University of Connecticut and Yale University; Delaware Bay, from the University of Delaware's College of Marine Studies; Chesapeake Bay, from the University of Maryland's Chesapeake Biological and Horn Point laboratories; and so on. The list of such associations continues around the coastal regions of the country.

I do not mean to imply that there have been no studies made of Boston Harbor. On the contrary, there have been many, dealing with various aspects of the harbor and costing millions of dollars. But most of them have been site specific and have dealt with such activities as dredging and construction; they are not of the nature required to develop an overall, comprehensive working knowledge of the harbor—one that is capable of supporting intelligent management decisions now and in the future. The recent development of Boston's 301(h) application for a waiver from the Clean Water Act's requirement that all communities adopt secondary sewage treatment is a good example of the inadequacy of such studies.[1]

Boston's 301(h) Waiver Application

A waiver from the Clean Water Act's mandated requirement for secondary treat-

ment of sewage can be granted to coastal communities provided they can demonstrate a lack of significant environmental impact on the ecosystem receiving the primary treated wastes.[2] Specific criteria are to be met in this regard, and the applicant is required to furnish evidence that existing or future discharges will meet such criteria. The Boston 301(h) waiver application was an expensive, narrowly focused information-gathering exercise that realistically could not have been expected to provide the comprehensive understanding needed to support long-term management strategy for the harbor and adjacent bays. Such knowledge cannot be amassed on short notice to expedite a particular project, no matter how important or urgent the project may be.

Given that extensive knowledge of the harbor/bay ecosystem had not already been secured, it was impossible to judge whether the criteria stated in the application had been met—for example, the requirement that the population of organisms living on the seafloor would not be significantly affected by the discharge of wastes.[3] Careful evaluation of naturally occurring changes in the native community structure of the bottom-dwelling organisms is required before changes due to pollutant stress can be determined. The work needed to perform this evaluation is time-consuming and expensive. Most municipalities have neither the expertise nor the willingness to support the effort needed to adequately define the balanced indigenous population. The effort made in this regard for the Boston waiver application fell short of providing a rigorous characterization of these communities for either Boston Harbor or Massachusetts Bay.

Environmental studies conducted in the harbor have been designed largely to meet specific regulatory or legal objectives. As a result, they generally fail to recognize the broader environmental consequences of the decisions they produce. Boston's 301(h) waiver application is an example of one of these studies. It did not consider the overall environmental consequences of the choice between primary and secondary treatment of its sewage. For instance, secondary treatment may well lower the input of contaminants to coastal waters but at the same time increase the risk that limited groundwater supplies will be contaminated (from land-filled secondary treatment sludge) and that there will be a deterioration of air quality (from incineration of sludge). In my opinion, we can no longer afford to maintain this myopic approach to problems that affect more than one segment of the environment. A recent decision by the EPA to tentatively deny a similar 301(h) waiver for the South Essex Sewerage District discharge was based largely on potential interference with recreational use of waters in the vicinity of the waste discharge.[4] Surely preservation of recreational water uses should not receive higher priority than increased human health risks posed by landfills or incineration of the toxin-laden sludge generated by most secondary plants.

It may be further argued from a scientific perspective that studies like the one conducted in preparation of the 301(h) waiver application inherently require comprehensive knowledge of the fundamental biological, physical, and chemical processes that may be affected by or that may affect contaminants released to coastal environments. For example, biological consequences of the contaminants include the inhibition of growth and reproduction and sometimes the death of organisms living in the vicinity of the waste discharge. Physical processes involve the circulation patterns that control the dispersion and transport of toxic substances away from the point of discharge of the waste. And chemical reactions

may occur that either enhance or decrease the toxicity of contaminants in the discharged waste. All these processes interact, making the accurate prediction of the effects of these contaminants difficult. The research necessary to produce such knowledge has been conducted for few if any such coastal areas in this country or, for that matter, in the world, largely because of the emphasis on expenditures for specific applied pieces of research that do not provide the perspective needed to adequately support critical management decisions. The study conducted for the Boston 301(h) waiver application is just one example of many such unsatisfactory expenditures. Indeed, the scientific community is probably better able to predict the consequences of waste disposal in open-ocean waters than in coastal waters, despite the more immediate relevance of the latter to human health and welfare.

Therefore, Boston's 301(h) waiver application, while attempting and often failing to meet specific requirements mandated by the law, also completely failed to generate the comprehensive picture required for future management decisions. The cost of this failure in dollar terms alone was and will continue to be immense: in excess of $2 million just for development of the waiver application and $2 billion plus worth of construction to clean up Boston Harbor.[5] Delays in the state's commitment to secondary treatment of its sewage while the waiver application was being prepared have resulted in the loss of hundreds of millions in federal cost-sharing dollars.[6] Costly errors in environmental decision making are likely to be repeated as long as there is a continued emphasis on narrowly defined, site-specific projects at the expense of an in-depth understanding of the basic issues involved.

Scientific Uncertainty

A brief description of the extent of current ignorance concerning the harbor and its adjacent bays is in order. The three primary areas of concern are biological, physical, and chemical processes.

Biological Processes

Boston Harbor supports an important recreational fishery (winter flounder) and commercial fishery (lobster and clams). Both are intimately coupled with and dependent on the production and growth of other members of the biological community, such as the primary and secondary producers. (Primary producers are plants that are capable of utilizing sunlight to produce organic matter. The organic matter of the plants may then be consumed by animals—the secondary producers—who in turn may be eaten by other animals, such as the fish and shellfish found in the harbor.) Disruption to any members that form a link in the harbor's "food chain" may substantially affect its other members. The dynamic linkage between various elements in this food chain has not been defined. Evidence gathered in the course of preparing the 301(h) waiver indicates that the bottom-dwelling communities in the harbor have been severely impacted. Winter flounder in Boston Harbor have one of the highest rates of cancer observed in any coastal fishery so far examined.[7]

Another increasingly common problem in estuarine and coastal waters is a phenomenon called eutrophication, which results from the addition of large

amounts of nutrients to natural waters. Nutrients essential to the growth of plants, such as inorganic nitrogen and phosphorous, are frequently present in high concentrations in primary and especially secondary treated sewage effluents. When excessive amounts of these nutrients are introduced into coastal waters, for example from the discharge of treated sewage effluents, higher than normal production of plant organic matter may result. Under some environmental conditions, the subsequent death and decay of the excess plant matter may lead to such a depletion of the water's oxygen that most forms of marine life cannot survive. The degree of eutrophication is dependent on a complex array of biological, physical, and chemical factors.

The extent to which eutrophication of the harbor and adjacent bays has already occurred or is now occurring has not been characterized. Low oxygen values have been observed both in the harbor and in Massachusetts Bay, but the information at hand is insufficient to establish the immediate causes of this condition.

Physical Processes

The extent to which we understand the physics of the harbor/bay system is crucial. Physical processes control the circulation patterns in the system and thus the rate at which the waters of the harbor are exchanged with those outside of it. These processes are therefore of major importance in the transport and ultimate distribution of contaminants released to the harbor's waters and in their eventual impact on the harbor and adjacent bay ecosystems. Assessment of the impact of waste disposal to such waters is obviously partly dependent on the extent of our knowledge in this regard.

Available information on the physics of the harbor is restricted to results of sporadic measurements of the temperature and freshwater content of harbor waters; evaluation of the mean tidal currents for navigational purposes; and several site-specific studies in the vicinity of existing and proposed major outfalls (the word *outfall* refers to the point at which a drain or pipe discharges wastes into a body of water). None of the results of these studies have appeared in the peer-reviewed scientific literature.[8] Measurements of the distribution of temperature, freshwater content, and velocity of harbor waters have been conducted neither frequently enough nor in enough locations to define how long water resides in the harbor (residence time) or to determine the physical circulation patterns of its water. Knowledge of both is required before the distribution and transport of contaminants in the harbor can be understood. For example, the concentration of a given pollutant in harbor waters depends in part on how long the water remains in the vicinity of a waste discharge. Clearly, a longer residence time will result in a higher concentration of contaminants in the water before it moves from the vicinity of the discharge. The residence time of water in different sections of the harbor can vary in order of magnitude, depending on a number of factors that have yet to be completely defined.

Several attempts have been made to develop mathematical models that describe the physical circulation of the waters in Boston Harbor and thus predict the dispersion of contaminants from the outfalls and combined sewer outfalls.[9] These include efforts by Hydroscience, Inc., in 1971 and 1973; EG&G in 1984; and M.I.T. in 1984 and 1985.[10] None of these models has been satisfactorily validated,

although work this year by R. F. Kossik, who compared the distribution of volatile organic compounds emanating from the Deer Island outfall with that predicted by the M.I.T. models, is a first step in the right direction.[11] Again, none of this work has been published in peer-reviewed journals.

Chemical Processes

Contaminant distributions within the harbor and adjacent bays have been only partially described. Sediment concentrations of metals are among the highest reported in the world's estuaries.[12] The limited data on organic contaminants, such as PAHs (polycyclic aromatic hydrocarbons) and PCBs (polychlorinated biphenyls), also establish Boston Harbor as one of the most grossly contaminated estuaries in the world.[13] The toxic properties of these inorganic and organic contaminants have been well established. These contaminants are also present in the sediments of Massachusetts Bay.[14] What we do not know is the exact nature of the sources of these contaminants, the mode of their transport, and their final fate and biological impact. For example, the degree to which contaminants released from the Deer Island and Nut Island outfalls are trapped in Boston Harbor sediments has not been adequately determined. M. G. Fitzgerald tentatively estimated that only about 3 percent of the input of selected metals to the harbor from the Deer Island and Nut Island plants is retained in harbor sediments.[15] If Fitzgerald's estimate is correct, the remaining 97 percent of the input has been transported to Massachusetts Bay and has therefore contributed to the contamination of its sediments. No such estimates are available for the retention of organic contaminants.

Concentrations of metals in the waters of Boston Harbor are ten to one hundred times higher than those expected in clean coastal seawater.[16] Concentrations of copper in the harbor frequently exceed current EPA water quality criteria. The distribution of this and other metals in harbor waters also indicates that sources other than the sewer outfalls may be of importance, especially in the Mystic and Chelsea rivers, where discharges from combined sewer outfalls may be most significant.

Sources of contaminants to Massachusetts Bay are even less well understood. Preliminary data obtained by Wallace and Gardner (in preparation) indicate that inputs from the Merrimack River and the atmosphere, not inputs from coastal waste discharges, are by far the most important sources of copper contamination in Massachusetts Bay. These sources may also be significant in the supply of organic contaminants to Massachusetts Bay waters and sediments.[17] Wallace and Gardner's data also suggest that metal concentrations in the water column of Massachusetts Bay may be two to three times higher than those of adjacent Gulf of Maine waters.

It is evident that the sources of contaminants to the harbor and Massachusetts and Cape Cod bays have not been well characterized. Even less is known of the transport and effects of these contaminants in this ecosystem. We do know that both physical and biological processes influence the movement and destiny of contaminants in coastal ecosystems. Contaminants released in areas having high-dilution rates may satisfy end-of-the-pipe requirements while still producing a selective concentration of the same contaminants in areas of active sediment deposition. This process, sometimes referred to as sediment focusing, may lead to

anomalously high concentration of contaminants in sediments and must be considered whenever wastes are disposed in the near-shore coastal zone. Information is nonexistent on the significance of this process in both the harbor and adjacent bay environments.

It has also been established that the toxicity of contaminants in aquatic environments is a function of their chemical and physical form. The particular form (speciation) of a contaminant—that is, whether it exists free, attached to a particle, or in association with another dissolved constituent to form a complex—greatly affects its toxicity, because these different forms are more or less likely to interact with a given organism. For example, a toxic metal attached to a particle cannot pass into the interior of a plant cell, whereas the same metal, if dissolved in water, may readily enter the cell and thus interfere with its internal biochemical machinery. Knowledge of the speciation of these contaminants is therefore of paramount importance if one is to assess the potential impact on the biological community. Failure to consider this factor may lead to major errors in the assessment of potential toxicity of contaminants. This in turn may lead to correspondingly large errors in determining the degree of control required to limit the input of contaminants to the ecosystem. The consideration of speciation is therefore of fundamental importance in the development of environmentally sound pretreatment requirements.[18] Ignorance of the speciation of contaminants, however, is not unique to Boston Harbor; it is a major concern among scientists and regulators worldwide.

Perhaps one of the best overall indicators of the current state of knowledge of the physics, biology, and chemistry of the harbor is the fact that fewer than ten papers describing the results of research conducted in Boston Harbor have been published in the peer-reviewed scientific literature.

The Need for a Vocal Constituency

I have already suggested the reasons for this current state of affairs—the lack of adequate funding for research in our coastal waters and a specific lack of interest in conducting research in Boston Harbor and Massachusetts and Cape Cod bays. The latter certainly to some extent reflects the former; that is, most who wished to pursue research in the harbor quickly recognized the inadequacy of support for such an effort at both the state and federal level. In contrast, other coastal estuaries enjoy an active and vocal support of efforts to understand and protect what people in adjacent communities consider to be an essential resource. This support has not gone unnoticed by the state and federal legislators who represent these vocal constituents, and the result has been the allocation of funds to support at least some of the research needed to protect and wisely manage these estuaries.

The lack of support for such efforts with regard to Boston Harbor and its adjacent bays was made painfully evident to myself and some of my colleagues when we were asked to define the problems facing Boston Harbor at a meeting held in Washington, D.C., more than a year ago. Sponsored by the National Oceans and Atmospheric Administration's Estuarine Programs Office and the United States Environmental Protection Agency, the meeting was designed to focus attention on the plight of many of our most severely impacted estuaries

and garner the necessary legislative support to begin to address these problems. Of the approximately fifty people attending the presentation, none could be readily identified as representing one of our legislative delegates to Washington.

On the other hand, those presenting the case for Chesapeake Bay attracted an audience of over twelve hundred. The Chesapeake is one of the estuaries chosen for inclusion in the EPA Bays Program. Also included in the program are Puget Sound, San Francisco Bay, Albemare Sound, Long Island Sound, Narragansett Bay, and Buzzards Bay. All enjoy a vocal citizens' constituency and/or the attention of influential legislators.

It is clear that until such attention is attracted to the needs of Boston Harbor and its adjacent bays, there is little hope of acquiring federal funds for support of the needed research. The scientific justification for funds is clearly there, indeed, perhaps more so than for most of the bays currently being considered for inclusion in the EPA Bays Program. The popular and political support is not yet in place. Recent progress has been made in this regard, however, with the formation of Save the Harbor–Save the Bay, Inc., a concerned citizens action group that has already made significant progress in the effort to build the necessary popular support.

Even if the required support were in place and the Boston Harbor/bay system were included in the EPA Bays Program, there is a reasonable doubt as to whether the heavily management-oriented and grossly underfunded Bays Program would permit the development of the necessary fundamental information. The common sense argument that one cannot hope to effectively manage what one does not understand has apparently failed to convince those responsible for the management of coastal resources that there is a need for comprehensive research programs. The agelong debate between the relative merits of so-called applied and basic research continues at the expense of progress in unraveling the mysteries of these complex environments. Unfortunately, it is the public who must pay the price in the end.

The $2 million plus cost of the recent Boston 301(h) waiver application is perhaps the best example of the cost of ignorance in this regard. Had the fundamental knowledge of the biology, physics, and chemistry of the harbor/bay system been available, the answers to the questions posed in the application process would have been at hand. Instead, a very limited and extremely expensive study was conducted which did little to alleviate our ignorance of the workings of this ecosystem. The cost became even greater when the federal share of support for the result of this study – a $2 billion planned cleanup of the harbor – dropped from 90 to 55 percent while the application was still being prepared. The price tag for persisting ignorance may become still greater, as waste disposal practices in Massachusetts coastal waters continue to be developed in the absence of information recognized as fundamentally important by scientists working in the field.[19]

The Need for Research

Why do we need to initiate a major research program to study Boston Harbor and Massachusetts and Cape Cod bays? One reason is that our lack of knowledge about the basic characteristics of this ecosystem has become coupled with

an immediate requirement for critical management decisions. The most urgent issue in this regard involves determination of the location for the outfall from the new secondary treatment facility to be built on Deer Island. The decision must be made by September 1987, in accord with a federally mandated court order.[20] This will be the largest such outfall in terms of flow in the country. It is also important to note that the secondary outfall effluent will still contain substantial concentrations of toxic contaminants and as such may significantly affect the quality of the receiving water. It is entirely possible that if the outfall remains in the harbor, EPA water quality criteria for copper may be violated. Continued degradation of the harbor environment will occur, although the impact will presumably not be as great.

Extension of the outfall to a location somewhere out in Massachusetts Bay may well be required. This decision should, however, be carefully weighed. The flux of contaminants to the bay may increase, depending on the efficiency with which the sediments of Boston Harbor serve as an effective trap of the contaminants now being released into it. Also, because the secondary treatment process does little to remove nutrients from the effluent and in fact may actually increase their concentration, the input of these nutrients to Massachusetts Bay may also become greater.[21] The enhanced flux of nutrients to Massachusetts Bay may serve to further aggravate the low oxygen levels that have been previously observed. Indeed, the observation of depressed oxygen concentrations in the bay contributed to the decision of the EPA to deny Boston's application for the 301(h) waiver. Unfortunately, information on the nutrient and oxygen dynamics of Massachusetts Bay does not exist, nor does knowledge of the necessary facts concerning the biological, physical, and chemical processes that can be expected to influence the fate and impact of the secondary effluent contaminants. In effect, because of our ignorance in these matters, we are about to initiate an environmental experiment of very large dimensions, the consequences of which may be substantially different from those anticipated.

Another reason to initiate a major study of the harbor/bay system is the fact that other sources of contaminants to Massachusetts and Cape Cod bays may be as important or more important than currently recognized ones. Future management strategies must take into account this possibility. Such huge expenditures of money as the $2 billion investment to clean up Boston Harbor must be justified by a demonstration of their real contribution to improved environmental quality.

Clearly, the transition from the current rudimentary primary treatment to secondary treatment will ameliorate the quality of the harbor environment. However, contaminants will continue to enter the harbor/bay system. We must do our homework and gain a much more sophisticated knowledge of what now must be considered one of the least understood harbor/bay systems in the country. The ultimate cost of the needed research, while substantial, is minute in comparison to the billion-dollar price tags for correcting past mistakes. Only when the results of such research are in hand will we be in a position to make the judicious decisions that will be necessary to guide the current reclamation and future preservation of our invaluable harbor resource. ❧

Notes

1. The formal title of this document is *Application for a Waiver of Secondary Treatment for the Nut Island and Deer Island Treatment Plants (Commonwealth of Massachusetts, Metropolitan District Commission, 1979)*. Section 301(h) of the Clean Water Act of 1977 (Public Law 95-217) amended the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) to allow waiver of the requirement for a minimum of secondary treatment by publicly owned treatment works discharging to marine waters. The applicant must demonstrate compliance with a number of requirements defined in the law. Approval of the application must be obtained from both the state and the administrator of the Environmental Protection Agency. A general overview of the evolution of laws governing discharges into marine waters may be found in James E. Krier, "Ocean Discharge of Municipal Wastes: Legal and Institutional Aspects," in *Ocean Disposal of Municipal Wastewater: Impacts on the Coastal Environment*, ed. Edward P. Myers and Elizabeth T. Harding (Cambridge, Mass.: Sea Grant College Program, M.I.T., 1983).

2. Primary treatment of sewage involves partial removal of solid matter and contaminants followed by addition of chlorine to the remaining waste effluent for disinfection purposes. Secondary treatment incorporates a second treatment stage to remove a much greater fraction of the suspended solids and contaminants from the raw sewage. The solids removed from the original sewage by either of these two processes are referred to as sewage sludge. The sewage sludge from the secondary process contains much higher concentrations of toxic contaminants than does the sewage sludge formed from the primary treatment because of the more efficient removal of toxins by the secondary treatment process. It should be noted that the secondary process, while more effective than the primary process, still leaves high concentrations of contaminants in the effluent.

   The water and residual solid material remaining after treatment by either process are then discharged through pipes, called outfalls at the point of discharge, which extend from the treatment plant into nearby coastal waters.

3. A wide variety of organisms live on the seafloor; this community is called the benthos (*benthus* is a Greek word meaning seafloor), or the bottom-dwelling community. The organisms present often are sensitive to alterations in their habitat incurred both by natural phenomena (storms, seasonal changes in temperature and food supply, and so on) and man's activities (for instance, waste disposal and dredging). The introduction of pollutants to the seafloor may substantially alter the abundance and composition of the communities of organisms originally present (referred to in the federal regulatory jargon as the "balanced indigenous population"), as the more sensitive species are replaced with more pollution-tolerant ones.

4. The EPA's decision to deny the waiver was conveyed in a letter to Mr. Craig Stepno, chairman of the South Essex Sewerage District in Salem, Massachusetts, from Michael R. Deland, EPA Region I administrator, on 9 April 1985.

5. The cost of preparation of the 301(h) waiver application was communicated to the author by Leslie O'Shea, chief of monitoring, Massachusetts Water Resources Authority. The estimate of the $2 billion plus cost to clean up the harbor was obtained from a report to the Commonwealth of Massachusetts Metropolitan District Commission entitled *Combined Sewer Overflow Project Inner Harbor Area Facilities Plan*, December 1982, prepared by O'Brien & Gere Engineers, Inc., of Boston, and from the *Supplemental Draft Environmental Impact Statement/Report On Siting of Wastewater Treatment Facilities for Boston Harbor*, December 1984, prepared by C. E. Maguire, Inc., of Providence, Rhode Island.

6. See Krier, "Ocean Discharge of Municipal Wastes." The present level of federal support for construction of wastewater treatment plants is expected to decrease under the current administration (information communicated to the author by Paul DiNatale, press secretary, Massachusetts Water Resources Authority, in a conversation on October 10, 1986).

7. R. A. Murchelano and R. E. Wolke, "Epizootic Carcinoma in the Winter Flounder, Pseudopleuronectes americanus," *Science* 228 (1985): 587.

8. Publication in the peer-reviewed scientific literature generally implies three things: one, that the work provides a significant advancement in our knowledge of the subject being investigated; two, that the methodology used was appropriate to the task; and three, that the interpretation of results and the conclusions drawn were justified by the data gathered.

9. Drains used to collect both stormwater and sewage are commonly referred to as combined sewers. Under normal flow conditions, the two types of wastes are kept separate by a barrier inside the pipe, and the stormwater part of the flow is collected and discharged through a pipe leading to the harbor, while the sewage part of the flow is collected and sent to the treatment plant. However, under conditions of heavy rainfall, the sewage becomes mixed in with the stormwater, resulting in discharge of untreated sewage through the combined sewer outfall. Even during dry weather, untreated sewage present in the combined sewer outfalls is flushed into the harbor. This is caused by nine- to eleven-foot tides that force water from the harbor to enter the combined sewer outfall; when the tide recedes, sewage is flushed out the end of the pipe. One-way gates are supposed to prevent intrusion of this tidal water into the pipes. However, many of these gates are malfunctioning. If this were not the case, most of the pollution from the combined sewer outfalls would be caused by occasional very heavy rainfall. As it is, the dry-weather discharges are more significant.

10. Hydroscience, Inc., *Development of Water Quality Models of Boston Harbor* and *Development of Hydrodynamic and Time Variable Water Quality Models of Boston Harbor*, prepared for the Massachusetts Water Resources Commission, Boston, 1971 and 1973, respectively; EG&G, *Oceanographic Study of Various Outfall Siting Options for the Deer Island Treatment Plant*, prepared for Havens & Emerson/Parsons Brinckerhoff, Boston, 1984; J. J. Westerink, K. D. Stolzenbach, and J. J. Connor, "A Frequency Domain Finite Element Model for Tidal Circulation," *Report No. 85-006, Massachusetts Institute of Technology Energy Laboratory* (Cambridge, Mass., 1985); and A. M. Baptista, E. E. Adams, and K. D. Stolzenbach, "The Solution of the 2-D Unsteady, Convective Diffusion Equation by the Combined Use of the FE Method and the Method of Characteristics," *Report No. 296, R. M. Parsons Laboratory for Water Resources and Hydrodynamics, Massachusetts Institute of Technology* (Cambridge, Mass., 1984).

11. R. F. Kossik, "Tracing and Modeling Pollutant Transport in Boston Harbor," Master's thesis, Department of Civil Engineering, Massachusetts Institute of Technology (Cambridge, Mass., 1986).

12. Gordon T. Wallace, "Boston Harbor and Massachusetts Bay, Status of the Habitat: Chemical Considerations," *NOAA Technical Report* (Washington, D.C., in press).

13. Michael P. Shiaris and Douglas Jambard-Sweet, "Polycyclic Aromatic Hydrocarbons in Surficial Sediments of Boston Harbor, Massachusetts, USA," *Marine Pollution Bulletin* (in press).

14. T. R. Gilbert, A. M. Clay, and C. A. Karp, "Distribution of Polluted Materials in Massachusetts Bay," *Technical Report of the New England Aquarium* (Boston, Mass., 1976).

15. M. G. Fitzgerald, "Anthropogenic Influence on the Sedimentary Regime of an Urban Estuary-Boston Harbor," Ph.D. diss., MIT/Woods Hole Oceanographic Institution, WHOI-80-38 (Cambridge, Mass., 1980).

16. G. T. Wallace, Jr., J. H. Waugh, and K. A. Garner, "Metal Distribution in a Major Urban Estuary (Boston Harbor) Impacted by Ocean Disposal," in *Urban Wastes in Coastal Marine Environments*, ed. D. A. Wolfe and T. P. O'Conner (in press).

17. John G. Windsor, Jr., and Ronald A. Hites, "Polycyclic Aromatic Hydrocarbons in Gulf of Maine Sediments and Nova Scotia Soils," *Geochimica et Cosmochimica Acta* 43 (1979): 27.

18. Pretreatment consists of removal of toxic substances from industrial waste water before the water is discharged into the sewer system.

19. A document entitled *Study Plan for Basinwide Management of the Boston Harbor/Massachusetts Bay Ecosystem* has been prepared for the Marine Resources Coordinating Committee of the Massachusetts Executive Office of Environmental Affairs, by the Technical Advisory Group for Boston Harbor and Massachusetts Bay. The document identifies those research and monitoring efforts deserving highest priority in light of currently recognized management needs. The Technical Advisory Group is composed of marine and social scientists as well as representatives of local, state, and federal regulatory agencies and public interest groups. Copies of the document may be obtained by writing Dr. Judith Pederson, Coastal Zone Management Office, Executive Office of Environmental Affairs, 100 Cambridge St., Boston, MA 02202.

20. *Schedule I Compliance Order*, U.S. District Court Case, *United States of America* v. *Metropolitan District Commission et al.*, Civil Action 85-0489-MA; and *Conservation Law Foundation of New England, Inc.*, v. *Metropolitan District Commission et al.*, Civil Action 83-1614-MA.

21. C. B. Officer and J. H. Ryther, "Secondary Sewage Treatment Versus Ocean Outfalls: An Assessment," *Science* 197 (1977): 1056.

LEGISLATIVE

MASSACHUSETTS WATER RESOURCES AUTHORITY ■ CHARLESTOWN NAVY YARD
100 FIRST AVENUE ■ BOSTON, MA 02129 ■ (617) 242-6000

MWRA OFFICIAL TESTIMONY

BILL NUMBER: HR 4883

SPONSOR: Congressman Gerry E. Studds

TTILE: THE MASSACHUSETTS BAY PROTECTION ACT OF 1988

POSITION: Support

SUMMARY: This bill amends the Federal Water Pollution Control Act to include Massachusetts Bay among the areas to be given priority consideration under the National Estuary Program.

Under the National Estuary Program, a comprehensive management plan for the Bay will be developed. The management plan will, among other things, assess trends in water quality, natural resources and uses of the estuary. The plan will develop a comprehensive conservation and management plan and will recommend priority corrective actions and compliance schedules to restore the integrity of the estuary. Federal grants are available for assisting research, surveys, studies, modeling and other technical work under the plan.

DISCUSSION: Designating Massachusetts Bay as a National Estuary will have beneficial effects on the Authority's operations. Federal Grant money will be available for testing, monitoring and corrective actions under the plan which will benefit the Boston Harbor Cleanup.

In addition, the program has a strong public participation element which will help to raise public consciousness about the Bay and will provide a forum for debate on what Massachusetts' goals for the Harbor will be.

In anticipation of this bill, Massachusetts has already convened a Management Committee.

(2)

The MWRA is participating in the Committee, together with Richard Delaney of Coastal Zone Management and representatives from the EPA.

7-26-88
date

Brian M. Leahy, Manager
Intergovernmental Affairs